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# COMPRESSED AIR MAGAZINE

DEVOTED TO THE USEFUL APPLICATIONS OF COMPRESSED AIR

Vol. xxiv MAY, 1919 No. 5

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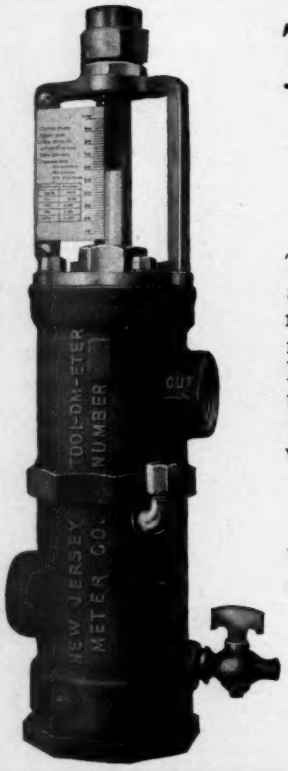


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# COMPRESSED AIR MAGAZINE

EVERYTHING PNEUMATIC

Vol. xxiv MAY, 1919 No. 5


## CENTRALIZED COMPRESSOR PLANT VERSUS INDEPENDENT COMPRESSORS

BY FRANK RICHARDS

I was very much interested in the article in the *American Machinist*, Feb. 27, page 395, [COMPRESSED AIR MAGAZINE, April, 1919, page 9106] giving an account of the employment of compressed air for various operations in the manufacture of 155-mm. shells at the works of Winslow Brothers Co., Chicago, Ill. Many establishments were rushed last year in the production of munitions, and the plant among them which did not use compressed air for some of its work would have been a curiosity. In the example above referred to, the special uses of the air were for the chucks on lathes and boring machines, for varnishing and for sandblasting the shells. I was especially interested in the following portion of the detailed description which I here reproduce verbatim:

"An interesting feature of the air-compressing installation is that, instead of being grouped centrally in a power house, it is distributed about the plant at convenient points where the air is most used. This saves long lines of piping and makes for efficiency, as it obviates to the greatest possible extent drop in pressure, due to friction in the transmission line caused by elbows and turns."

Now, I feel compelled to say at once without hesitation and without apology, that while the feature to which attention is thus called is certainly "interesting," it is also to me most surprising. It is at variance with all experience and practice, and the claimed advantage is absurd. A single compressor could have been installed in the power house of the works, or anywhere most convenient, the air could have been distributed throughout the establishment, and the pressure maintained so that there would not have been more than 1 lb. of pressure drop at the remotest point. This may be substantiated by the records of hundreds of compressed-air installations where the pressures carried are anywhere up to 80 or 90 lb. gage, and the distribution areas very much larger than in this case. Here there were four similar compressors, two-stage, with air cylinders 14 in. and 8¾ in. respectively, with a common stroke of 10 in.—quite small machines as compressors go today. A single machine, the exact equivalent of these in theoretical capacity, would have had at the same piston speed, air cylinders 28 in. and 17½ in. in diameter; but, with the greater piston speed permitted to the larger machine, air cylinders 24 in. and 14 in. in diameter would have fully equalled the air output.

Under the conditions which rule wherever compressed air is employed, and especially was it so in this case, the air is used intermittently, and the demand for the air at the source of supply is irregular. The consumption of air in operating the various chucks spoken of must have been very small, since they are worked by static pressure and not by flow or loss of air. By far the larger volume of the air, we must assume, was used for the varnishing and the sandblasting, and especially the latter, since for these, when actually operating, there would be a continuous discharge of air; but here too the work was not continuous for any machine, and the machines would seldom, if ever, be operating all at once.

The demand for air from each of the four compressors was of course never coincident with that of either of the others. The air demand would have been much better averaged and equalized if all the air had been drawn from a single compressor, and a single air receiver, approximately equal in capacity to that of the four smaller ones would have been better to meet the demand.

Having regard to the fluctuating and unequal air consumption, it would seem, from all that appears, and from all that may be legitimately inferred, that a single central compressor with cylinders 20 in. and 12½ in. in diameter would have afforded a sufficient supply of air in this case. The cost of such a machine might be about one-half of that of the four smaller ones. The single line of distributing pipe would probably cost less than the extra shafting, pulleys and belts, and the piping for cooling water for the four isolated machines. The extra cost of attending the four separate machines, the multiplicity of the lubrication, the fourfold liability of stoppage for repairs, need not be spoken of.

The article which we have been considering calls attention to the special air-drying arrangement provided for the air to be used for the sandblasting. With a single air compressor, an effective aftercooler and a separator, the latter operating upon the air when at its highest pressure and at its lowest temperature, or when its moisture carrying capacity would have been at the minimum, would have provided the advantage of dry air for all the purposes for which it was used, instead of for the sandblasting alone.—*American Machinist.*

## A PNEUMATIC SCRAPER FOR FINE MACHINE WORK

One of the most responsible and delicate operations of the machinist, requiring both skill and perseverance, is the scraping of metal surfaces, usually cast iron, where minute accuracy or fine precision of fit is required, as in valves and valve seats and the slides of lathes, planers and other machine tools. The operation is usually entrusted only to workmen of long training and it has hitherto been regarded as strictly a hand operation.

The Anderson Brothers' Manufacturing Company, Rockford, Ill., is now building an air driven scraping tool which is a demonstrated success and a valuable acquisition in high class machine shop equipment. The illustrations here presented and most of the accompanying description are reproduced from the April issue of *Machinery.*

The scraping tool, seen in actual use in Fig. 1, is carried at the end of a long arm, and the air cylinder and operating parts are located at the opposite end of this arm. To facilitate the manipulation of the tool this air cylinder and its auxiliary mechanism are carried by a trolley which may easily be run back and forth on the supporting rail in order to enable the scraping tool to reach exactly the desired position on large pieces of work. The operator holds the scraping tool firmly down onto the work with the left hand, and the right hand is used to manipulate a knurled sleeve which actuates a valve in the air cylinder. When this knurled sleeve is pushed forward it allows the air to enter the cylinder and forces the scraping tool forward. As the only effort required of the operator is to hold the tool down onto the work he is relieved of the additional effort of pushing the tool forward, and as a consequence he does not become so tired during the latter part of the day that his working efficiency is greatly reduced.

The trolley rail and trolley by which the heavy end of the tool is supported will be seen up at the left in Fig. 3. The lower views are arranged as shown to illustrate the design in more detail, attention being called to the fact that when the tool is ready for use, threaded fit *B* is assembled into socket *C*, and a pin passes through hole *D* at the right hand end of the valve rod and hole *D* shown in the

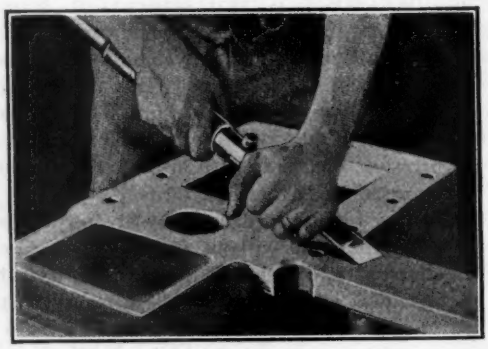


FIG. 1

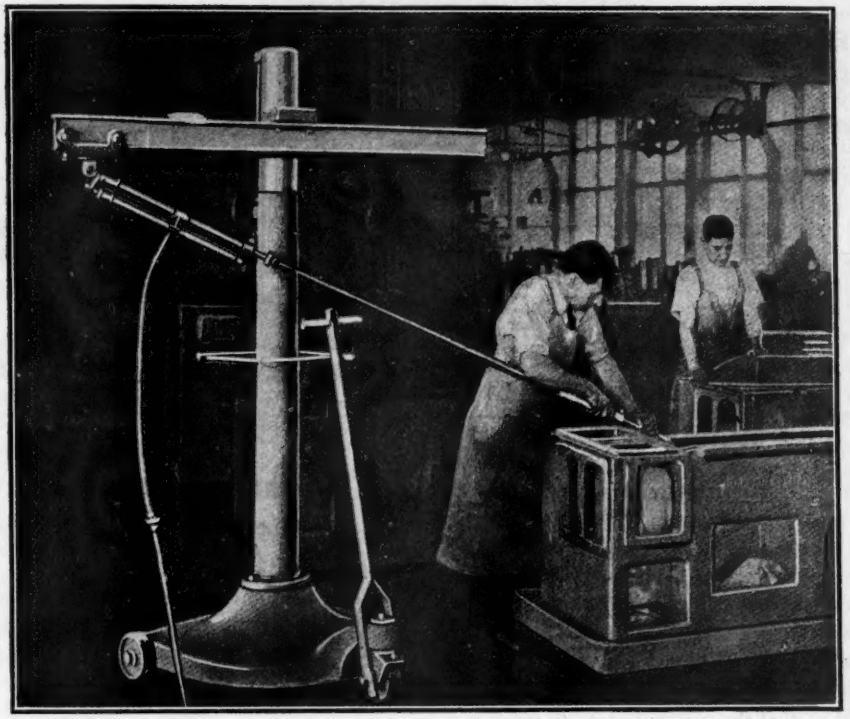


FIG. 2

lower view, in order to provide for connecting the valve rod with knurled sleeve *E* which controls the operation of the scraping tool. When the knurled sleeve *E* is pushed forward it opens valve *F* and allows air to enter the space *G* in the cylinder behind the piston.

It will be seen that the piston is connected by means of posts, all of which are designated by the reference letter *H*, with the scraping tool which is mounted at *A* at the right hand end of rod *H* and secured by the setscrew shown. When knurled sleeve *E* is pushed forward to open valve *F* and admit air behind the piston, it causes the piston to move forward, and through this direct connection a similar forward movement is imparted to the scraping tool carried at *A*. The length of stroke may be governed either by releasing sleeve *E* when the tool has reached the desired point on the work, or by allowing the piston to travel forward until such a time as it reaches the exhaust ports which allow the air pressure behind the piston to be released. The valve *F* is normally kept in the closed position by means of a spiral spring *I*, and when the valve is closed, back pressure of air against shoulder *J* on the piston causes the piston and the scraping tool to be returned to the starting position.

When the scraping tool starts to move forward on its working stroke, it would be undesirable to have the trolley which supports the back end of the tool move along the rail. This possible cause of trouble has been effectually overcome by providing an automatic clamping mechanism which locks the trolley to the rail at the same time that the scraping tool starts on its working stroke. The way in which this result is accomplished is as follows: When valve *F* is opened to admit air behind the piston, some of the air also passes through port *K* to the swivel point between the air cylinder and the trolley. Just below the trolley there will be seen a detail view of the bolt which connects the back end of the air cylinder to the trolley. After passing through port *K* the air enters an annular space *L* beneath the nut on this bolt and thence passes through ports *M* to reach an annular groove *N* that is cut around the body of the bolt at

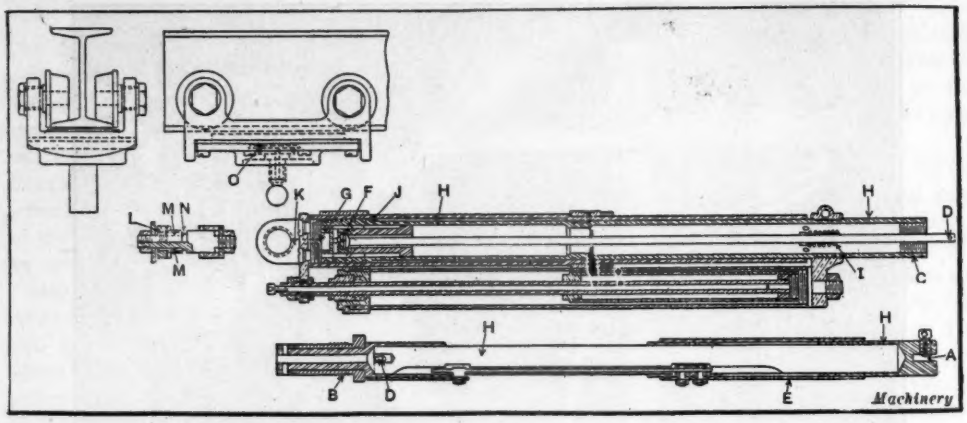



FIG. 3

the center. From this annular space the air passes up to a diaphragm *O* which locks the trolley to its rail during the time that the air pressure is admitted to provide for driving the scraping tool forward. When valve *F* in the air cylinder is closed to shut off the pressure and stop the working stroke of the tool, the air pressure on diaphragm *O* is also released so that the trolley is free to move and allow the scraping tool to reach any other desired point on the work.

The speed of the forward stroke of the scraping tool is regulated by an oil governor. About eight cubic feet of free air per minute, at a pressure of eighty to ninety pounds per square inch is consumed in operating this tool, although this fact is of very little importance. The rod that carries the scraper is mounted on ball bearings so that it may be turned over to enable both sides of the tool to be used in the same way that a hand operated tool is employed. This arrangement also enables the tool to adjust itself to the work, regardless of the angle of the surface that is being scraped, although it will usually be approximately horizontal.

The rail on which the trolley is carried may be supported in any convenient way; it may be either secured to the ceiling of the shop or mounted upon a special pedestal base designed for the purpose as shown in Fig. 2. This pedestal enables the height of the rail to be adjusted to suit different requirements.

## AIR COMPRESSORS AND RECEIVERS FOR DIESEL ENGINES*

BY HERBERT HAAS

The air required for starting the engine and for atomizing and injecting the fuel is furnished by an air compressor. On account of the high pressure necessary the air is compressed in two or three stages. Ample cooling of the compressor cylinders and of the air in intercoolers between stages is not merely desirable, to approach isothermal compression, but is necessary to avoid accidents that might wreck the compressor, with possible injury to the operators. With insufficient cooling of air and excessive use of cylinder lubricating oil, or of an unstable oil, the oil vapor may form an explosive mixture with the heated air and be ignited by compression. Three-stage compression is therefore much to be preferred, as it permits compressing the air more gradually, and the lower compression-ratios avoid excessive terminal temperatures.

### AFTERCOOLERS

The air leaving the last compressing cylinder should be placed through an aftercooler and an oil separator before it is stored in the air receivers. This step is taken not so much to prevent a drop in pressure in the injection air bottle, with the contraction of the heated air in cooling, as to avoid explosions of the

*From a continuous treatise on the Diesel engine in current issues of *The Gas Engine.*

heated air charged with oil vapor. Regrettable accidents have happened from failure to provide intercoolers and aftercoolers. Not only pipes but air receivers as well have burst. Flame passing through the air pipe and into the air receiver charged with oil vapor has ignited this vapor and blown up the receiver. The aftercooler cools the air, and the oil-and-water vapors are condensed in the separator, and from time to time are drained off.

The air compressor should be lubricated thoroughly, but without the use of an excessive quantity of oil. The oil used should have a paraffin base, should be of great stability at high temperature, and should have high flash and burning points.

### COMPRESSOR ARRANGEMENTS

The air compressor is usually driven direct from the main shaft of the engine. On multi-cylinder engines with closed crank case the compressor usually has the appearance of an additional cylinder, the compressor cylinders and pipe coil air coolers being surrounded with a mouth forming a water space.

On some engines, especially large units, more than one compressor is used to avoid the large size necessary with only a single compressor. Moreover, greater accessibility and reliability are obtained, and the work of compression is divided into a larger number of smaller absolute impulses.

Compressors may be vertical, horizontal or inclined for both horizontal and vertical engines. They are made of cast iron, with water jacketed cylinders, or are surrounded by a mouth which forms a large water space and in which are housed the air cooling coils. More systematic cooling can be done by using water jacketed cylinders and independent intercoolers. Also, these then become more accessible. The cylinders are stepped down to correspond to the number of stages.

The valves are metal pappet or disk valves. The discharge and intake valves between stages are perferably housed together in one cage, of a construction that facilitates their removal and replacement. The high pressure demands small clearance spaces; the interior of the cylinder head end should conform closely to the inner surface of the cylinder; the end of the piston, likewise, should conform to the shape of the cylinder head to permit its close approach. Each inter-cooler should be fitted with an oil separator, so that excess lubricating oil and condensed water may be separated and drained off and not allowed to pass on to the next stage.

A blow-off (safety) valve should be placed in the high pressure air pipe leading to the air receiver, directly back of the high pressure end of the compressor (past its discharge valve), to prevent the bursting of the pipe as the result of any obstruction.

Compressor troubles are probably responsible for a large proportion of the shutdowns in the operation of the Diesel engine. Particular care should be used in compressor construction to make all the parts as simple as possible and still retain the maximum efficiency and reliability. Valves should be readily interchangeable, and the material and workmanship of the highest order.

### AIR RECEIVERS

The air from the compressor is usually stored in three air receivers, two large ones for the air used in starting the engine and a smaller one for the injection of air. These receivers are made of seamless drawn steel, and to avoid heavy walls and excessive weight are relatively long and of small diameter (L/D=4 to 8). They are interconnected with a system of pipes controlled by valves, so that either of the large bottles may be replenished with air from the injection-air bottle, which is supplied from the air compressor. The valve bodies are machined out of solid forged-steel blocks. The valve bodies are connected to the air pipes by copper cones and steel gland nuts. The valves are controlled by large (8-inch) handwheels.

One of the large air bottles is used for storing a reserve supply of air under a pressure of 1,000 pounds per square inch. Air is drawn from the other when the engine is started. The latter bottle is refilled as soon as the engine is in operation. The air compressor is designed amply large to replenish, in 15 to 20 minutes running, the air so used, without drawing on that used for injecting the fuel with the engine at full load. Manometers are provided to indicate the pressure in the large bottles and the injection-air bottle and the intermediate pressure of the compressor. At least one of the large air receivers is filled with air at the manufacturer's works and shipped with the engine to be used in starting

it for the first time. Before the engine is started at any time the operator should convince himself that every part of it is in operating condition; should he fail to start it by turning on the starting air, he should close the air valve at once and locate the cause of failure rather than make a number of attempts and waste the compressed air.

If all the air has been used before the operator has succeeded in starting the engine, which operates the compressor for producing a fresh supply, compressed carbon dioxide (carbonic-acid gas) can be used in lieu of compressed air. To prevent the freezing of the gas when it is drawn, the top part of the container may be warmed by wrapping cloths soaked in hot water around it. The container should not be heated by such means as torches, as there is great danger of bursting it from overheating the gas.

The size and the number of air receivers vary with the size of the installation. In power plants using a number of engines it is well to interconnect the air receivers of the different engines, so that any one can be drawn upon in emergencies for any of the engines. Small engines need a relatively greater air-storage capacity for horse-power than do large engines. The capacity required varies from 15 to 20 gallons per 100 horse-power for the injection-air bottle and from 60 to 200 gallons per 100 horse-power for the starting-air receivers.

### REGULATION OF AIR SUPPLY

The air supply to the fuel valves is regulated by throttling the discharge valve on the injection-air bottle, and the desired pressure, indicated by a manometer on the injection-air bottle, is maintained by correspondingly throttling the air going to the air compressor at the air intake.

Each bottle is provided with a cock and a drain pipe reaching to the bottom of the bottle to drain it of accumulated condensed water and oil.

For starting some engines low-pressure air is used (100 to 250 pounds per square inch), which is stored in the standard type of sheet-steel, riveted air receivers. The receivers are filled with air drawn from the injection-air bottle and supplied by the air compressor. In other engines the air receivers are eliminated together and a seamless steel pipe is used between the compressor and the fuel valves, the pipe taking the place of the injection-air bottle. A separate small compressor driven by a gasoline engine supplies the starting air. This practice lowers the first cost of the engine, but the absence of any reserve makes it necessary that the compressor furnishing the injection air be of unfailing reliability. With the opening and closing of the fuel valves and the lack of sufficient receiver capacity the pressure fluctuates, and with an obstruction in the pipe the pressure may rise abruptly and burst the pipe, as even the precautionary blow-off valves can not be depended upon to act unfailingly. The presence of a gasoline engine with its highly inflammable fuel introduces a fire risk that is absent in installations that derive the starting air from the engine-driven compressor and have in the engine room only a small supply of fuel oil with a high flash point. This advantage of the Diesel engine should not be appraised too lightly in many industrial plants, such as textile and flour mills.

### MATERIAL FOR THE AIR PIPES

The injection-air and fuel pipes subjected to the fuel-pump pressure are made either of seamless-drawn copper or steel. Copper pipes are preferable on account of their greater ductility and uniform strength, even though they have a lower tensile strength than steel pipes. Seamless drawn-steel pipes have failed, owing to local imperfections, where copper pipes have satisfactorily stood the test; but no receiver system or pipes are entirely safe against rupture if the air discharged from the air compressor is not first cooled to remove any entrained oil. For conducting the air used in starting the engine a seamless drawn-steel pipe is used; this pipe is of larger diameter and, as the pressure of air used for starting should not exceed 500 pounds per square inch when admitted to the engine cylinder, is safe. This air is usually at atmospheric temperature and the danger from ignition of explosive mixtures of air and oil vapors is absent.

For circulating cooling water and supplying fuel oil to the fuel-storage tank in the engine room standard black or galvanized-iron pipes are used.

### SOURCE AND VOLUME OF AIR USED

The air for the engine is taken directly from

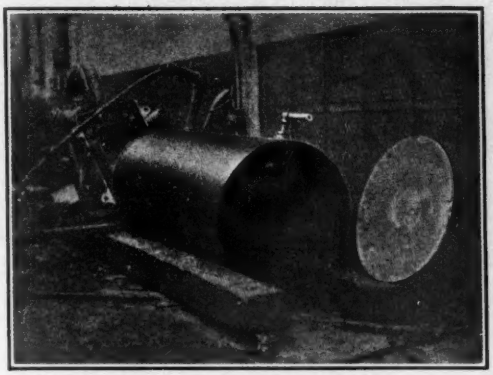
the engine room or from the outside. If the air is taken from the engine room, the customary method is to bolt to the facing of the cylinder head a cast-iron elbow, connecting this with the intake to the air valves; the elbow points downward and is connected with a short length of steel pipe (one elbow and one pipe for each cylinder). Its end is closed with a cap. The air enters through a series of long slits cut into the walls of the pipe. This arrangement lessens the noise and prevents foreign bodies from being drawn into the engine.

As the volume of air drawn into the engine is considerable—about 635 cubic feet per minute for a 100-horsepower engine having a four-stroke cycle and about 850 cubic feet per minute for an engine having a two-stroke cycle—especially in large installations, means of admitting an excess of air to the engine room must be provided. However, the noise will probably be considerable and the windows will vibrate and shake under the continuous waves produced by the periodic air displacements. It is therefore a better plan in large installations to draw the air from the outside through large conduits built in the foundation and connecting with the different air intakes to the valves.

## EXPLOSION OF A "WELDED" AIR RECEIVER

R. L. Hemingway, Chief Boiler Inspector, California Industrial Accident Commission, exhibits in *California Safety News* the illustrations, which we here reproduce, "as a warning," so he says, "against welded heads of air pressure vessels."

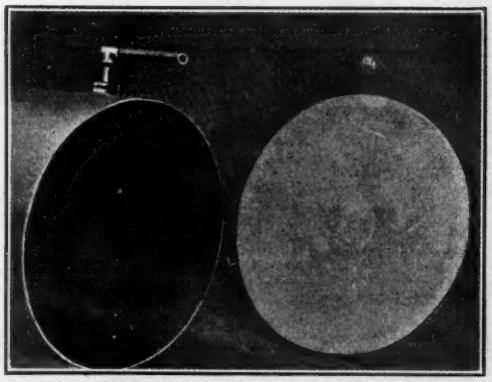
The exploded receiver here shown was mounted in connection with an 8 by 10 in. compressor driven by a 13 h.p. motor. It was 28½ in. in diameter and 6 ft. long. The shell, also welded was .194 in. ($^3/_{16}+$) thick and the heads .259 in. (¼+) thick. The head was not flanged over as is ordinarily done to fit inside the shell but was flat at the periphery and trimmed to the exact diameter of the shell; then the head was laid against the end of the shell, and even these contacting surfaces were not welded, as shown after the explosion, the



COMPRESSOR AND EXPLODED RECEIVER

welding consisting only of a skin which covered the visible joint on the outside. "The dishing of these heads was exceedingly unsatisfactory, in that it was too flat and also was not formed to a true and continuous curvature." There was a ⅞ in. through rod, not a bolt, fitted loosely in central holes in the heads, and the flush ends of the rods were welded over. A test of the safety valve after the explosion showed that it blowed at 95 lb., but whether this pressure was reached does not appear.

The report of the Chief Boiler Inspector of the California Industrial Accident Commission says: "This is only one other instance of the unreliability of welding." We must protest that it is nothing of the kind. This



RECEIVER AND HEAD

was self evidently a shameful, a criminal, malapplication of the welding process, and true, honest welding was not on trial.

## EXPERIENCE WITH A DENSE-AIR ICE MACHINE

BY C. H. WILLEY

In a country club where a three ton Allen dense air ice machine had been installed to supply cool drinking water, a daily supply of 350 pounds of ice and the cooling of the storage rooms, I was called to find out why the machine would not work properly. In spite of all efforts of the man in charge the machine would not build up sufficient pressure in the system. Upon asking questions the operator told me that about a month ago when they were giving the machine a general overhaul and had the expander piston out to smooth up some scores in it, that when they replaced it the machinist failed to tighten it securely in the cross head and it gradually worked out until it drove out the cylinder head and cracked the cylinder. A new cylinder was obtained and installed, but when the machine was started it would not even frost the pipes. After considerable hunting and puzzling the engineer decided that the expander valve was to blame and that by changing its setting he could make it run right. So he took out the valve and added on 3-16 of an inch to each end. Then he put it back and the machine seemed to do better for a while. Finally it got worse, and at this stage I was called.

I checked up the valve settings and immediately removed the built up valve and plugged the screw holes where he had added the pieces, then set the valves according to the maker's directions for a three ton machine which measurements for the expander cylinder are: Lower valve, 1-32nd of an inch lead; upper cut-off valve, closes or cuts off at 6¼ inches. With these settings and a properly designed valve obtained from the makers the machine would operate all right.

It seems so foolish to think that anyone would attempt to change a valve length or design, or for that matter, any other part of a machine which is designed and manufactured by experts, and especially so when one stops to realize that several thousands of these machines have been sold and are highly satisfactory. Many troubles could be avoided if operators of these dense air ice machines would give them the proper care and study out the principle of their operation so that they could more readily trace a trouble and hit upon the right solution. The writer who has given some thought to and for eight years has operated these machines, therefore hands on these pointers.

These machines when started up take the air from the atmosphere through what is known as the primer pump, and gradually build up the pressure in the system to five atmospheres, (60 to 70 lbs.). It is when the system is so charged at this pressure that it does its work of cooling. This is the pressure in the system. This air is then taken by the compressor cylinder and compressed to 210 to 240 lbs. (a ratio of 3 to 1 being about right between pressures). Compressing the air heats it. Heat that is stored up by the labor expended upon compression is partly removed by passing it through a copper cooling coil immersed in circulating water, which reduces the temperature to nearly that of the water. The air then passes into the valve chest of the expander which is in construction very much similar to the usual steam engine equipped with the riding cut-off valve. The valve admits the compressed air (210 to 240 lbs.) upon the piston of the expander cylinder to a certain point of the stroke and then cuts off. The piston continues to travel to the end of the stroke, the air exerting pressure upon it which constantly diminishes by expansion. This takes out of the air a quantity of heat equal to the labor performed by the air expanding. The result is a very low temperature at the end of the stroke. The return stroke pushes the cold air out into the system at a pressure of 60 or 70 pounds.

The expander helps the steam cylinder and the compressor takes the power. The expander cylinder cut-off valve must cut off the pressure at such a point that the expanded air at the end of the stroke of the piston is very nearly the same as the pressure in the system out into which it pushes it.

Many troubles can be avoided in the operation of the dense air machine if they are given the proper care. A few points on their operation that will help are given here.

Do not overtax the capacity of the machine. The amount of piping used in refrigerating the storage boxes of rooms should be such as to give about one square foot of outside surface of piping to three square feet of interior room surface (ceiling, sides, and floor, interior divisions not counted) for the rooms which the cold air enters first. For later rooms 2½ square feet, and when a very large amount of room is to be cooled the last room should have about one square foot of refrigerating surface for two square feet of interior room surface. It is best to have the cold air enter the room first near the ceiling, especially in the later rooms, so the air currents may ascend to near the ceiling. The rooms that are to have the advantage in being kept cold should have the cold air first.

The two most vital points, to be sure, are first, that your circulating water through your coil (and water jacket around the compressor cylinder) is properly circulating. An item in connection with this is to see that this piping through which the circulation water is drawn from the sea and delivered to the cooling coil is well lagged, especially if it has to come through warm compartments, such as boiler rooms over boilers. Next, that when for any reason work is being done on any part of the system or valve chests or cylinders, great care is given to keeping the interior free from air and grit. A small scratch or score on the face of the compressor valve will very vitally affect the proper work of the machine. These valve surfaces must be tight and a lubricator installed to give them an occasional drop of oil. The oil must be of ice machine class, able to stand heat and cold. A good mineral oil from which paraffin is removed by freezing is suitable. All joints should be very carefully made, as air leaks do not take up, but get worse in time. Once every three months a pressure of 60 to 70 pounds should be put on the pipes, and every part of every joint, and every bolt head should be carefully inspected and tested by putting on a lather of soap with a brush, so that any leak will be easily detected by formation of air bubbles. These leaks must be stopped in a permanent manner. Joints are generally made with thin rubber gaskets and the joint painted with litharge and glycerine. An occasional draining out of the bottom of the coils in the refrigerating room helps.

The whole piping system should once a year be steamed out and then blown out. The machine should run at an average of 50 to 150 revolutions according to the number of boxes or rooms being cooled or the volume of air being used.

All stuffing boxes on the machine piston rods should be well packed and kept tight. Be careful not to score the rods. Every tiny leak about the machine means loss of efficiency in refrigeration.

The piston leathers of the compressor and expander cylinders should last ordinarily about two months. They can be resoaked in castor oil and when swelled used over again. There should be a steel forming die (similar in construction to the piston in which the cup leathers are used), in which a spare set of leathers should be tightly clamped and formed. This die with the leathers in should be submerged in a can of castor oil. This treats the working edges of the leather to a soaking bath in the oil and keeps the main part of the leather that is clamped in the die or on the piston dry, the feature of this being that when the spare leathers are placed in use in the machine they will not require constant following up to squeeze out the oil and take up the slack.

The leathers should be made from oak-tanned leather slightly less than ⅛ inch in thickness and cut 5/8 inch to ¾ inch larger in diameter than the cylinders, according to size. When these leathers give out, trouble will be experienced with a loss of pressure. Sometimes the high pressure decreases in relation to the low, and sometimes just one cylinder may lose pressure and the system shows a loss of cold.

The clearance of the setting of the primer pump that makes up the air leaks is also a very important item. It should be the very least possible with regard to safety in striking. About 3-64-inch is right. The clearance in any of the cylinders of the air part is very small, so that very little change is permissible in the wearing parts and they must be very frequently checked up. When removing and replacing the nuts on the piston rods when putting in leathers, the unscrewing of the rod or the least movement of it in its crosshead must be guarded against. I think the change of these small clearances is the cause

of the breakage of many cylinder heads that I hear of from time to time.—*Refrigeration.*

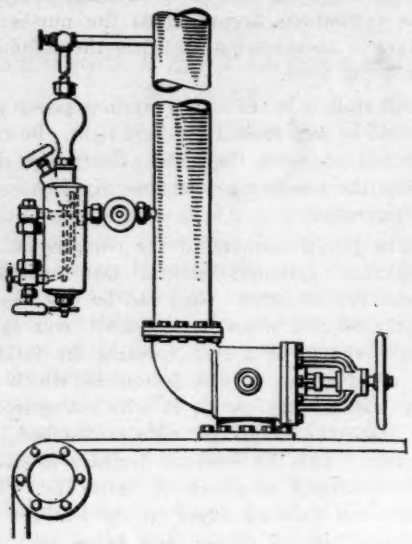


FIG. 1

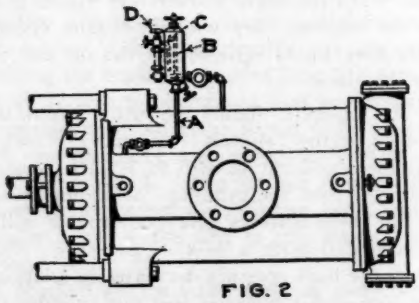



FIG. 2

## SIGHT FEED LUBRICATOR ON COMPRESSOR

BY P. A. GETT

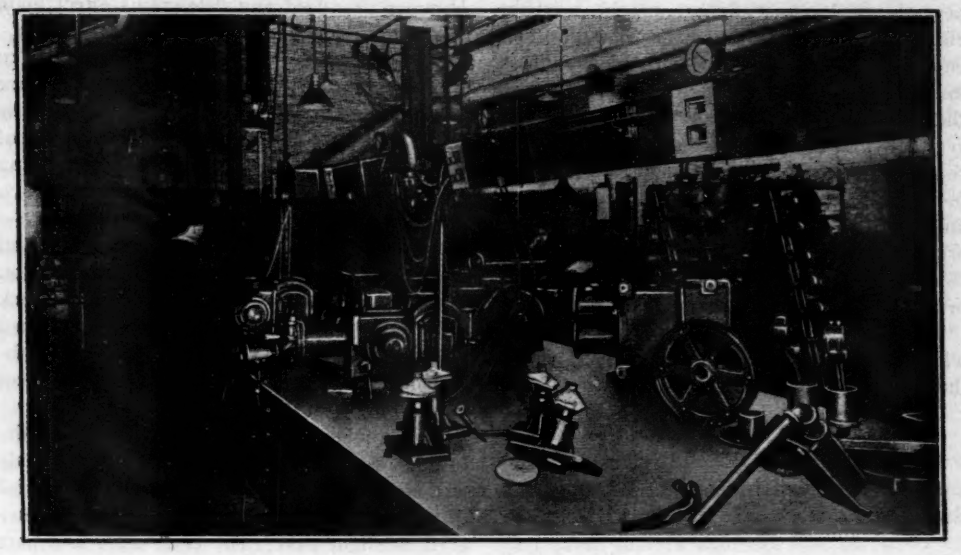
In moving a large air compressor, the lubricator was accidentally broken and damaged beyond repair. When the piston was taken out, the cylinder and piston were found to be badly scored owing to lack of oil, so it was probably a good thing that the lubricator broke, as either it had not been working properly or someone had neglected to keep it filled. An old hydrostatic lubricator was found about the place, and I set about to fix it over to use on the air cylinder.

Fig. 1 shows such a lubricator as it is connected up for use with steam, and Fig. 2 shows how it was rigged on the air cylinder. The condensing chamber was taken off and the lubricator turned upside down and a connection from the discharge side of the compressor hooked in where the condensing chamber had been. The feed connection was turned down and connected into the top of the cylinder at midstroke.

The action is as follows: The air pressure enters from the discharge manifold, through the pipe *A* and tube *B* to the top (originally the bottom) of the lubricator and forces the oil out through the tube *C*, needle valve *D*, and on through the sight-feed glass and discharge tube into the compressor cylinder. The operation is positive from the fact that there is always an unbalanced pressure between the two connections because the compression pressure has only risen to about half the discharge pressure when the piston passes the discharge connection of the lubricator at midstroke, and from this point to the end of the stroke there is suction on this connection and there is always discharge pressure on the other connection.—*Power.*

## AIR SCREENS FOR FURNACE WORKERS

An account was recently given in a German technical paper of the latest methods employed in Germany for screening furnaces. Workers tending furnaces, and required to examine the glowing material at frequent intervals, suffered a great deal from the excessive heat radiated, and various devices have been tried to minimize the ill effects. For example, hollow water-cooled furnace doors have been tried, but obviously they afforded protection only while closed. Again, devices have been installed for drawing off the hot air in front of furnaces by centrifugal exhausters placed in front of the furnace opening. An objection to these is that workers are subjected to great variations in temperature prejudicial to health. According to the article quoted, the most effective device is to fix immediately behind the furnace door a narrow, oblong nozzle, through which cold air is blown upward, thus interposing a screen of relatively cool air between door and furnace. This arrangement is to give adequate protection to the worker, and has the incidental advantage when the doors of the furnace are opened the escape of flame is checked.



OVERHAULING BENCH

## OVERHAULING AIR BRAKE COMPRESSORS

The term "overhauling" is used to include the removal of the compressor from the car, the dismantling of all parts, the cleaning and renewing of the parts as necessary, the replacing of all broken or excessively worn parts and their reassembling with proper lubrication.

Such an overhauling can be best and most quickly done on an overhauling bench specially constructed for convenience and thoroughness in carrying out the work. The compressor overhauling bench shown in the accompanying illustration, from *Electric Railway Journal*, is installed at the Southern Division inspection and overhauling shop of the Brooklyn Rapid Transit System. It consists of a zinc-covered platform 19 ft. long, 7 ft. wide and 25 in. high, with an open space on all sides. Such a bench will accommodate eight compressors, and all the auxiliary piping, electrical connections, storage reservoirs, etc., are arranged with eight units, so that the work of overhauling and testing on one compressor need not interfere with that being done on others.

Sixteen 14 in. by 18 in. reservoirs are installed under this bench. They are connected in series and piped in pairs so that each compressor can be used to charge two reservoirs. The air thus compressed in these tanks is used for various operations in the air brake room. At the center of each side of the bench is a tap for attaching a hose so that the air may be used for blowing out and cleaning the compressors being overhauled. At one end of the bench a connection is provided so that the air may also be used for testing and adjusting door engines, more than 7,000 of which are used on this property. At the other end of the bench there is a connection to the air hoist which is used for handling the compressor while it is being overhauled.

A bench for overhauling other air-brake parts extends along the wall at the side of the compressor bench, and the reservoirs also supply air to this bench. A board extends over the top of the compressor overhauling bench for supporting the various contact boxes, switch and fuse boxes, gages and governor used with the electrical connections to the compressors. This board is 11½ in. wide and is supported by a 1-in.-pipe framework 4 ft. above the top of the bench. The contact boxes have two contact fingers, one for the positive and the other for the negative side of the compressor connections. The boxes are made of asbestos lumber and are fireproof. At one end of the leads used for connecting to the compressors is a plug contact. This consists of a flat piece of hard rubber with copper plates on either side. By shoving this

between the contact fingers in the box the electrical connections are made. At the other end one of the leads is provided with a knuckle joint connector for connecting to the compressor field and the other has a brass ferrule for insertion in the brushholder. These connections can be made very readily. Each individual testing circuit is protected by a 10-amp. fuse and a knife switch. A single governor regulates the cutting in and out of the compressors while being tested but each is provided with a separate air gage.

The bench is lighted with eight drop lights with shades. Extension cords are used where the light is needed closer to the work.

## EFFECT OF PNEUMATIC TOOLS ON WORKMEN*

BY FRANCIS M. BARNES, JR., M. D.

Within the past two years complaints of ill effects from the use of the pneumatic hammer have become prevalent, although these do not seem to have originated so much with the individual user of the hammer as with labor organizations of which he is a member. It has been claimed that the use of the hammer produced in the men a diseased condition affecting the nervous system and leading even to paralysis, insanity or other form of complete incapacitation.

### NO COMPLAINTS IN THE MEDICAL RECORDS

In view of the fact that in current medical literature no mention of such diseased condition from this causation could be found it became necessary to carry out an investigation to determine, if possible, whether such disease actually did exist, its extent and seriousness, and, if necessary, to study measures whereby its occurrence could be minimized or entirely done away with. Such a study is obviously of importance, not only to the workman, but to the operator whose interests are more broadly involved.

Recent investigations have been carried out in parts of the country where the pneumatic hammer is used in shipbuilding and in the steel industry. From reports of such investigations as are available it was not found, in any instance, that the use of the pneumatic hammer produced any deleterious effect upon the general health of the workers.

So far as this study is concerned the men using pneumatic hammers on limestone were found to be in good general health, none of the group examined showing any constitutional disease; their troubles (supposedly arising from use of the hammer) being limited to a disturbance of the function of the left hand—commonly known as "white fingers" or "dead fingers." As a general thing this condition occurs shortly after the men first go to work in the morning, or until they have "warmed up," although it also occurs during cold weather when the hands are exposed otherwise than in working.

First the little finger and that side of the left hand (in right-handed men) become pale and blanched; the same area soon giving rise to tingling or numbing sensations, sometimes even to slight pain. The ring finger and part of the middle finger may also be involved in this process. By swinging the arms or rubbing the hands the condition may be made to disappear and when the hands are warmed the pallor rapidly gives place to diffuse flushing and reddening. The index finger and thumb of the right hand are occasionally affected, particularly in those workers who improperly control the exhaust by their finger or thumb.

### EFFECTS DUE ENTIRELY TO THE COLD

So far as could be determined this condition of the hands constitutes the sole trouble from which the stone workers complain in so far as the pneumatic hammer is concerned. In all of the workers examined the hands were somewhat reddened and flushed, but not more than reasonably might be expected in the hands of outdoor workers. The hands were calloused to a varying degree in different subjects, but in all quite extensively. The palm and certain of the fingers of the left hand were more calloused than on the right. There was no actual cyanosis, excepting in one subject, where this was slight. No swelling, no tenderness, no pain, no edema and no involvement of the muscles or joints. Paresthesia was absent excepting in one subject, who reported some numbness in his "white fingers." This was the only subject to show the condition well developed. Sensation for all tests was acute and practically normal. In most subjects there was a lowering of acuteness of

*Abstract from paper at Seventh Annual Congress of National Safety Council.

feeling—some blunting or dulling—but this certainly was no greater than could be expected in hands where so much callous was present. In all but one subject the callous was sufficient explanation for any variation from the normal which could be observed in sensation. In this one subject the sensory disorder passed off in a few minutes or as soon as the hands became warm. Mental disease was not present in any subject examined, nor was there any physical disease which could in any way be attributed to the occupation.

Such disorders of the extremities indicate quite clearly that a disturbance of the peripheral circulation of the blood is responsible for their occurence. The caliber of the peripheral blood vessels, and therefore the amount of blood supplied to the part, is dependent in large measure upon the action of the nerves which supply these blood vessels, known as vaso-motor nerves. Low temperatures stimulate the sensory nerve fibers in the skin and the nerve impulses thus aroused reflexly stimulate the vaso-constrictor center, or a part of it, and cause blanching of the skin. That cold may produce evident changes in the appearance of certain parts of the body, notably of the extremities—the feet, hands, ears and nose—is a matter of common observation.

It has been pointed out that exposure of the hands to cold usually produces at first a pallor of the skin which is evidently due to a constriction of the cutaneous arterioles. When the exposure is prolonged, however, the color is heightened and the skin usually becomes more or less cyanotic. Almost universally, therefore, cold produces a constriction of the cutaneous arterioles and a slow flow of blood through the skin. The variations in color are thus caused by the varying amounts of blood that collect in the skin capillaries. The flow through the blood vessels is also in part influenced by the muscles which surround them. Anything, therefore, which interferes with or impedes the normal action of the muscles will have its effect in turn upon the circulation, as it is the changing state of contraction and relaxation of the muscles which aids in the flow of blood under normal conditions. Where a group of muscles is held in a contracted state for a considerable length of time the circulation is thereby impeded.

With the workman, whether using a chisel and mallet or a pneumatic hammer, the factors of cold, continued muscle contraction and cutaneous irritation are all present to a considerable degree, and demand due evaluation in the consideration of such disorders in the hands as are sometimes observed. The fact, borne out with uniformity in this investigation, that the trouble occurs only in cold weather indicates most conclusively that the low temperature itself is one of the most important factors in the causation. The continued muscular contraction and the mechanical irritation (vibration) may play a role in its causation, but evidently these are of secondary importance.

### THE HAMMER HAND NOT AFFECTED

The fact that the trouble, when present, preeminently affects the left hand, which holds the chisel and not the hammer, indicates clearly that other factors than the hammer itself are more signal importance in its causation. The cramped position of the chisel hand with the more or less continuously maintained contraction of the muscles is one of these important factors. However, the hammer or the grip of the chisel, either alone or combined, are not sufficient to produce the condition, as is proved by the fact that it does not occur in the warmer seasons of the year when industry is at its height. The role of the vibration is uncertain, but as the trouble occurs in the hand not holding the hammer, it is doubtful if this factor is of much importance. We have left, therefore, the factor of low temperature which seems to be the final and most important element in the production of those vascular changes seen in the hands of some workers which, although physiological in nature, form the pathological basis for the occurrence of "white fingers" and "dead fingers." So far as can be ascertained the condition leads to no permanent disability and results in no organic disease. Why it is that only a portion of stone cutters are affected cannot be answered. Whether certain undetermined conditions of poor general health or specific diseased condition existing, but not recognized, predisposes certain men to this disturbance is not evident from this investigation, although apparently such is not the case. With one or two exceptions they were all well developed, robust men without demonstrable general physical or mental disease.

SOME OF THE CONCLUSIONS

Structural steel workers, shipbuilders and stone cutters as a class, enjoy good general health and are not, because of their trade, especially susceptible to any particular disease.

Stone cutters are liable to a disorder affecting the hands, especially the left hand. This disorder of the hands is of a vascular character, not due to organic changes in the circulatory system, but dependent upon vaso-motor reactions. These reactions are physiological in character and are occasioned by three factors incident to the work of stone cutting: Mechanical irritation of the skin, continued muscular contraction of a cramping nature and low temperature. Of these three factors, cold is considered the most important because the condition only occurs during the severely cold weather and never in the summer, and warmth and measures to restore the circulation (rubbing, swinging the arms and the like) cause its disappearance.

It cannot be caused by the effect of the air hammer alone because it occurs in those who have not used the air hammer. It does not occur in warm weather when industry is at its height and, therefore, when the air hammer is most in use. It occurs mostly in the left hand and not in the right hand in which the hammer is held.

The institution of measures to warm the chisel before and while using, enlarging the shank of the chisel and covering it to make it possible to hold without so cramping a grip, the wearing of gloves, and the discontinuance of the prevalent custom of blocking the exhaust outlet, and thus forcing a draft of chilled air out along the chisel and onto the fingers of the left hand would do much toward the prevention of this trouble.

## TEMPERING DRILL STEELS FOR JACKHAMERS*

Many thousands of pounds are being spent by the mining groups on jackhamers. Consulting engineers and mine managers are studying the question as to which is the best machine on the market, etc. In my opinion, greater attention should be given to the tempering, sharpening and shanking of the drill steels. A few days ago I watched the Kafir drill sharpeners at work on a mine where the officials are endeavouring to make the jackhamer a success. The drills were being sharpened at a rapid rate, but the natives were absolutely ignorant of the method of tempering or hardening the bits or cutting edges. They have no knowledge whatever of the colour of the heat required to harden the drills. These were plunged into the water at a yellow to a dull red heat and several times at almost black heat! How can jackhamers be a success when such steels are used? I examined a number of shanks and found the striking end on some broken and not square; this is fatal to pistons. The wonder is that jackhamers do as well as they do under such conditions. The best method of tempering drill steels that I have seen on these fields is at the Brakpan Mines, where the steels are re-heated for tempering by two natives and handed to a third who plunges them when the requisite heat colour is obtained. A study of this method is well worth the consideration of other mines. Considerable saving would be effected by the appointment by each group of a qualified "Steel Temperer and Drill Sharpener" to inspect this work. The amount of steel used would be considerably lessened, the cost of upkeep of the rock drills would be less, and the number of holes drilled per machine per shift would be increased.

*Correspondence *South African Mining Journal.*

## AMERICAN WELDING SOCIETY TO BE FORMED

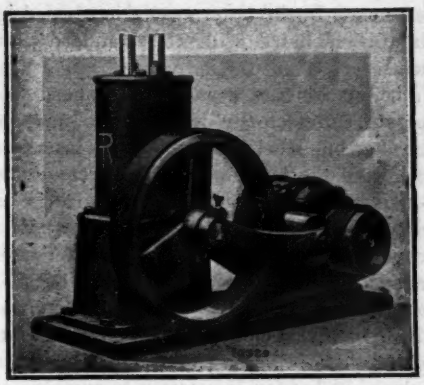
A new association, to be known as the American Welding Society is being formed through a merging of the Welding Committee of the Emergency Fleet Corporation and the National Welding Council. Other men interested in the application of welding to shipbuilding, and, in fact, to all manufacturing processes, are also included in the new society.

Scientific societies and experts in all the welding fields will be brought together to aid in the maintenance of a Bureau of Welding, which will be a separate organization, designed to carry on research and aid in the standardization of welding as a process.

The organization, through its dues, will provide funds for research, will superintend the carrying on of research, advance and training of expert welders, and serve as a medium to accomplish advantageous legislation and suitable publicity for the work.

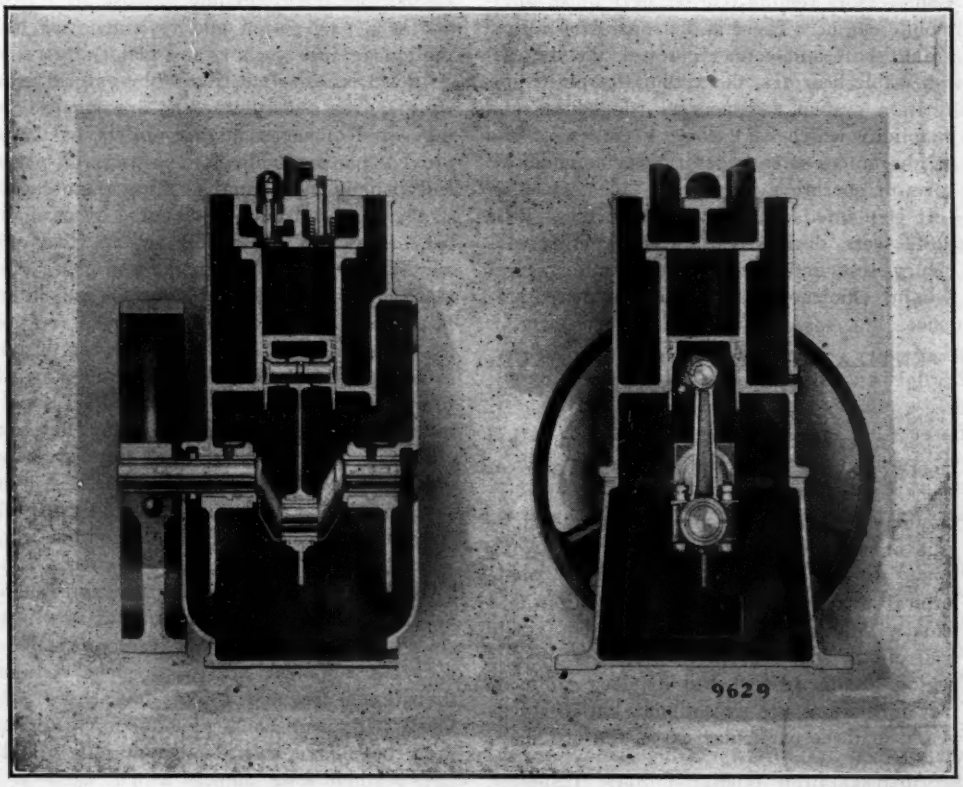
## A LITTLE WAR COMPRESSOR NOW READY FOR ANY JOB

When, in the emergency at the outbreak of the war, there was a sudden call for a large number of small air compressors for service where reliability was imperative, the Ingersoll-Rand Company's offer, to produce for immediate use the Imperial Fourteen Compressors which it had just completed testing out and had adopted as the new standard small compressor type, was accepted. The field performance of these built-on-hurry-order machines was watched with critical eye, but after a year's service their record was clear. They had proven themselves efficient, reliable, and inexpensive to operate.



LITTLE WAR COMPRESSOR

Now these little machines have been placed on the general market. There are four sizes and the capacity range runs from 3 to 45 cubic feet per minute at pressures up to 100 lbs. per sq. inch. The small compressors can, however, be used for pressure requirements up to 200 lbs., the horsepower needed being, of course, slightly increased. They are single acting machines of the vertical type built for belt drive. Where driven from line shaft, tight and loose pulleys are supplied; where the use of independent motor is planned they are ordinarily furnished as a unit complete with motor, endless belt and short drive at-




VERTICAL SECTIONS OF COMPRESSOR

tachment. In the latter case a hardwood base plate is included with the standard equipments.

The machines are so well balanced as to operate satisfactorily if bolted to any solid flooring, but where permanecy of installation is desired the building of a concrete foundation is advocated. The smallest size is built with ribbed cylinder for air cooling where the service is intermittent and with water cooled cylinder of the reservoir type for continuous operation. Larger machines are water cooled only, employing the reservoir jacket system except that, in the case of the largest size, a closed jacket for connection to pressure system is optional. In this connection it is worth noting that the reservoir cylinder design affords unusually ample water capacity and that both cylinder barrel and head are cooled. The manufacturer states that a single filling of the water space will suffice for a 10 hour day's run.

In general design the Imperial Fourteen Compressors remind one strongly of an automobile engine. There is the same drop forged crank shaft and connecting rod, the die-cast renewable bearings, the automatic splash lubrication system and general ruggedness and simplicity which have come to be recognized as guarantees of satisfactory service under all sorts of operating conditions.

It is pointed out, however that these little units were designed to meet exacting efficiency test and that, while simplicity was sought, efficiency was the insistent requirement.

## VENTILATION METHODS IN COEUR D'ALENE MINES*

BY ROBERT N. BELL

The metal mines of this State (Idaho) are mostly in high mountain regions. Those of the Coeur d'Alene have their vein outcrops on the mountain-sides, and are developed by adit or cross-cut tunnels to depths varying down to over 2,000 ft. This gives ample natural gravity air-pressure circulation that usually affords good ventilation and is easily controlled. The natural advantages of this region in this respect and its deep sedimentary formations are exceptional, but in recent years, in three particular cases, the ore penetration has been developed extensively below the lowest points of surface-drainage entry, involving cross-cut tunnels, three of which are two miles long. In these cases the tunnels are of a minimum size of 7 by 8 ft., and are used for drainage, haulage, and ventilation. They are costly openings to drive, and owing to the uncertainty of results to be found a double-entry tunnel was never warranted as it is in coal mine development, and the further fact that return outlets are invariably provided at high elevations for air circulation.

Above these deep drainage-levels, ventilation by natural gravity air-currents was a simple matter; but each of these mines, and several others in lesser degree, have shown persistence in their orebodies to great depth below these lowest drainage-entries, and the sub-levels thus developed have rapidly expanded in the past few years. This involves a new problem in ventilation, where the long tunnel is depended upon for the main air supply, by reason of the fact that the long electric ore-trains running in these air-courses act as a part piston and resistance when in motion against the air, and materially retard its flow. Sub-level ventilation by natural gravity air, even with these deep drainage advantages and numerous higher outlets, has lately proved inadequate in volume and velocity to fully supply the normal working requirements of the men, and must be assisted by mechanical means. A ventilating system that will simply carry away the smoke and gases from blasting and emanations from men and lights, is a mistaken economy in big mine operation, as the great harm resulting from an insufficient supply of good air is markedly shown in the behavior of the men employed in such a mine. Surliness, discontent, inefficiency, and a general desire to cut work or sojer are often directly traceable to poor air, and there is no investment that will pay a bigger return in resulting efficiency of the workers than good ventilation.

The long tunnels of the Morning and Bunker Hill & Sullivan mines, due to the natural wall resistance and moving trains, are incapable of carrying sufficient air to properly ventilate their extensive and rapidly deepening sub-levels without mechanical induction. Fortunately, both have several other outlets in addition to their long tunnels which, while at a much higher level, can be used and are used

*Abstract from report of State Inspector of Mines for 1918.

as additional sources of fresh air, with the return or up-cast directed through still other outlets. These matters have been under discussion for the past four years with the State Mines Department, and the managements of those mines have been entirely willing and anxious to improve their ventilating conditions. To do so, however, in addition to mechanical installations, it involves the driving of several thousand feet of expensive straight-line raise connections, but as labor has been so scarce this work has been decidedly retarded.

In this connection, as men have been available, over 900 ft. of big raises have been driven at the west end of the Bunker Hill mine and are now being extended, to be used exclusively as an air-course, and during my visit to the property in December, a large station was being cut for a recently ordered 60,000-cu. ft. Sirocco fan. This is to take fresh air not only from the Kellogg tunnel, but also from the adjacent Sweeney shaft and other west end outlets, affording an ample supply for all purposes, when mechanically driven and controlled, to the deepest point of the mine with the necessary air-doors and stoppings. Present plans contemplate, if it is found necessary, the installation of another large Sirocco fan near the head of the No. 2 East shaft, which is a natural up-cast, and will afford a permanent circuit through the East end outlets, above the Kellogg tunnel. This is the deepest mine in actual ground peneration in the plane of the vein in the Coeur d'Alene. Its orebodies are entirely in quartzite formation. They vary in size up to 100 ft. in horizontal cross-section and 900 ft. in length. The mined spaces are uniformly timbered with square-sets and closely filled with waste. The levels are 200 ft. apart vertically and 300 ft. on the dip of the vein, which is 40 degrees. The hottest place in the mine is 1500 ft. above the bottom level at the apex of the Cameron stope at the No. 10 level cross-cut connection. This is one of the largest stopes in the mine that has been actively operated for the past 12 years. At this point the temperature is 80 degrees. The humidity reaches dew-point, and is largely due to local faulting, the friction of slowly packing fill, oxidizing timbers of the big stope, and the fact that it is a converging point of return air.

The highest bottom level temperature in the mine at the new 15th level, which is 4800 ft. on the dip of the vein below its highest crest, and 3400 ft. vertically under the mountain, registered only 70 degrees F. This point is 5400 ft. in the pitch of the main ore-channel below discovery cut. The top of the big stopes at No. 13 and 14 levels registered 75 degrees, and the No. 2 shaft-station main return air-course at the 13th level, 70 degrees.

These are comparatively low temperatures for such depths. The mine, however, is damp throughout and the relative humidity is high in all these sub-levels, causing men to perspire freely at work, this giving the impression of much higher temperatures than actually prevails. The only remedy for this humid condition is a greater volume and velocity of fresh air-currents, and the company is making an earnest effort to attain this improved condition, which, I think, will shortly be accomplished.

At the Hercules mine, with a drainage cross-cut tunnel at its lowest point from Canyon creek only a few hundred feet short of two miles in length, the natural ventilation in its new sub-levels is still good. Its new vertical four-compartment shaft from this level is 1400 ft. deep, but only three sub-levels have yet been opened down to the 600-ft. level. The large underground hoisting-stations are completely sealed with tight-air doors. The main shaft in the winter carried 30,000 cu. ft. of fresh air in December, affording ample ventilation for the present levels, by way of the shaft, drifts, stopes, and up-cast through several large rock raises to the No. 4 tunnel outlet, 600 ft. above No. 5, a natural return-circuit in the summer. Stations are now being cut in the new shaft at the 800 and 1000-ft. sub-levels in this mine, where the natural temperatures are slightly under 70 degrees and well ventilated by an exhaust fan at the 600-ft. station.

The Hecla mine has a natural advantage in ventilation from the fact that its main working shaft starts at the surface, and does not involve the long adit approaches of the other mines mentioned. It is ideally situated for natural gravity-air ventilation, and the management has taken full advantage of this condition. This mine has a drainage-level on the course of its ore-zone several thousand feet, striking directly into the east side of the

abrupt slope of Canyon creek, near the main surface shaft-collar. The main shaft now has a maximum depth to its new bottom station of 2,000 ft. vertical. The bottom working-level is at 1600 ft., and the lineal distribution of the orebodies are strung out through fully 3,000 ft., and duplicated with several parallel shoots of ore with many raises, chutes, and manways at short intervals.

Near the east end of the ore development an expensive straight-line raise, nearly vertical and 1400 ft. high, was put through to the surface from the drainage-tunnel for ventilation purposes. It gives a maximum gravity vertical range to the 1600-ft. level through connecting raises for natural air pressure of 3,000 ft., with several other outlets above the drainage-tunnel to relieve the main west stopes. This theoretically presents almost ideal conditions for natural-gravity air circulation.

The main shaft has a large-size idle compartment, and each station drift-entry is provided with an air-door. In December this shaft, acting as a natural down-cast, was distributing 28,000 cu. ft. of fresh air per minute at high velocity through the lower levels, with return through numerous outlets to the surface. The recent rapid expansion and duplication of the operating openings and ore-shoots of this mine, all heavily timbered, develops a heavy resistance to free air circulation, in spite of its extremely high chimney-draft value. It also retards the flow of the return air, which is believed to be due, in part, to lack of proper splits in the west orebody, a condition that the company's engineers are now studying carefully with a view to remedy by additional doors and stoppings. If this is not effective, a powerful Sirocco fan will be put in as an exhaust, probably at the head of the No. 3 tunnel, 1400-ft. raise.

The temperature at the new 2000-ft. station in this mine in December was 70 degrees, with relatively high humidity. Like all the other sub-level mines, the maximum or warmest place tested in this one, due to the same cause of temperature localization as the Bunker Hill & Sullivan and Morning mines, was at the top of an exhausted stope on the 600-ft. level, 1,000 feet above the bottom working-level, which gave a reading of 70 degrees.

## GET A BLASTING EXPERT

In the actual loading, tamping and wiring of charges in drill holes there is little variation of method, and relatively little labor is involved; hence no appreciable amount of labor can be saved by modifying the mechanical processes connected with blasting.

However, efficiency in blasting has a direct bearing on the amount of labor required subsequently. Improper arrangement of drill holes, imperfect balancing of charges, or the use of too strong or to weak an explosive, may result in a very inefficient blast, and, as a consequence, the loading of rock may be greatly hampered. In fact there is no other department of the quarry in which inexperience or lack of judgment may in a brief period occasion more disastrous consequences.

This is particularly true where many large blasts are fired simultaneously in deep churn-drill holes, for the mass of rock thrown down may occupy the rock loaders for a period of several weeks or even months. If the rock is imperfectly shattered, or improperly thrown down, excessive secondary blasting may be required, and the loading may be slow and difficult throughout the entire period. Hence, it is false economy, both of money and labor, to employ inexperienced men as blasting foremen.

A realization of these facts has led some operators to engage the services of blasting experts, who are not permanent members of any quarry organization but travel from quarry to quarry as their services are desired. Such an expert, in accordance with the judgment gained by long experience, supervises the arrangement and spacing of drill holes, selects the explosive, proportions the charge for each hole, carefully inspects or tests all connections, and fires the charge. The efficiency of the results usually obtained amply justified the employment of such experts.

If, on the other hand, blasting is done by an experienced man of good judgment, the subsequent operations may be greatly simplified. If the rock is thoroughly shattered, little labor is required for secondary blasting, and if the rock fragments are thrown down in a way that permits easy handling, loading may be done rapidly and with minimum effort. —*Pit and Quarry.*

## IS COMPRESSED AIR USED ENOUGH ON CONSTRUCTION WORK?

Although electric power is ideal where rotary motion is produced, it is not very satisfactory where reciprocating motion is desired. Thus, for drilling, tamping and the like, compressed air or steam is preferable to electricity. Compressed air is also suitable for use in driving rotary tools or machines, such as augers, hoisting drums, etc. Hence there is a very wide field of usefulness for compressed air, a wider field than is generally realized by construction engineers and contractors.

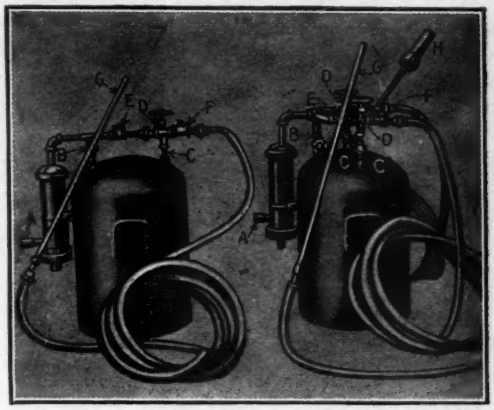
Portable compression plants driven by gasoline engines are already used extensively, but for every one now in use there should be a score or more. There is rarely a large construction job on which a portable compressor would not prove profitable. To enumerate only a few of the uses of such a plant will serve to indicate its general applicability. Thus, there is: Ramming or tamping of concrete, earth backfill, ballast, etc.; drilling with hammer drills, piston drills and rotary earth augers; boring wood for bolts and drift-bolts; hammering drift bolts and spikes; adzing and dropping timber; cutting pipe threads; toothing out paving brick and chipping the mortar from old brick; operating small hoists, swinging derrick booms, etc.; riveting; operating grindstones, small saws, etc.; pneumatic painting and sandblast cleaning.

With wages 50 to 100 per cent. higher than they were five years ago, there is greater need than ever to use labor saving machines and devices. Compressed air tools furnish an admirable means of reducing labor costs on construction work—*Engineering and Contracting.*

---

## PREHEATERS FOR WELDING OPERATIONS

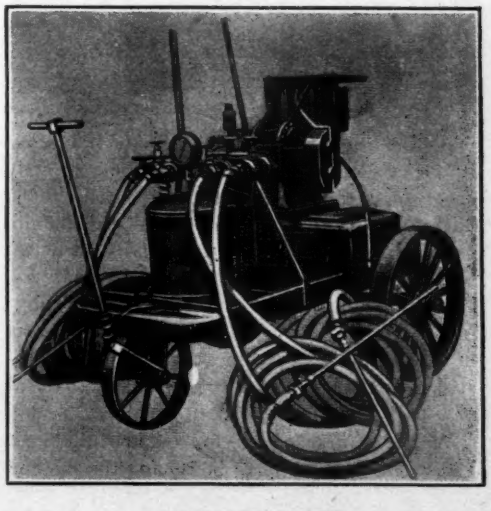
As practically all ordinary welds, except those on pipe, require preheating it is well wherever possible to use heaters made for the purpose. We show here preheaters made by the Metal and Thermit Corporation designed to make the preheating work as easy and convenient as possible. In Fig. 1 are shown a single and a double burner. For small jobs the single burner, which may be fitted with a flaming burner also, will probably answer the purpose. Where a number of welds are to be made, however, the double-burner apparatus should be selected. In these



TWO PREHEATERS

illustrations *A* is the place to attach the hose from the compressed-air supply; *B* is the valve for regulating the pressure on the surface of the fuel; *C* is a tube which runs within a few inches of the bottom of the tank; *D* is the needle valve which controls the fuel to the burner; *E* is the air pressure control to the burner; *F* is a check valve which prevents back fire; *G* are torches or burner pipes; *H* is a flaming burner. The small tank on the left side is a water separator for the compressed-air supply.

Fig. 2 shows a four-burner portable apparatus used largely for rail-welding work. It carries its own air compressor, which may be run by attaching to a trolley wire or to some other electric-current supply. All of these burners use either gasoline or kerosene.



PORTABLE PREHEATER

| Symbol | Specific Gravity Baume | Flash Point Deg. F. | Fire Point Deg. F. | Cold Test Deg. F. | Viscosity Saybolt Sec. |
|---|---|---|---|---|---|
| A | 26.5 | 500 | 550 | 55 | 115 at 212 deg. |
| B | 29.5 | 440 | 490 | 35 | 385 at 100 " |
| C | 31 | 400 | 450 | 20 | 180 at 100 " |

## LUBRICANTS FOR AIR COMPRESSORS

The little table here reproduced is taken from an extensive article on Lubricants for the Power Plant in *Power Plant Engineering*, April 15, by Reginald Trautschold.

In connection with the table it is remarked that the dry heat encountered in air compressor service necessitates the use of only particularly stable lubricants. Oil A is a very heavy, filtered straight mineral oil. It is unusually free flowing for such a heavy oil and is intended for service where the temperature in the cylinders is above normal (325 deg. F.). Such temperature is common in many single-stage compressors, particularly after the equipment has been in service some time, and for such units an oil of the grade of A should invariably be used. Oil B is also a filtered oil, intended for use in multistage compressors where the temperature is high. It is also an excellent lubricant for new well-cooled single-stage machines. Oil C is of medium viscosity and is intended for well-cared for multi-stage machines that are tight.

## EXHALED AIR AND DIFFUSED BODY HEAT

The following table gives the composition of pure air and of respired air:

| | PURE AIR | RESPIRED AIR |
|---|---|---|
| Oxygen. . . . . | 20.35 | 16.2 |
| Nitrogen. . . . . | 78 10 | 75.4 |
| Carbon Dioxide. . . . . | 0.30 to 0.04 | 3 4 |
| Water Vapor. . . . . | 1.5 (variable) | 5. |

As the respired air is immediately diffused in the air of the room, it cannot be directly removed, but only diluted till it ceases to be harmful. There is, therefore, no definite standard of purity, and any line drawn between good and poor ventilation is arbitrary. Pure air contains 3 to 4 parts of carbon dioxide in 10,000. With an increase to 11 parts in 10,000, the air becomes noticeably oppressive, while an increase of 3 parts or a total of 6 to 7 parts is scarcely noticeable.

We have first of all to consider the heat generated by the human body, and the method of its disposal, which are important conditions determining the most desirable room temperatures, and in densely peopled buildings, largely determining the result of vital processes dependent in part upon the activity of the individual.

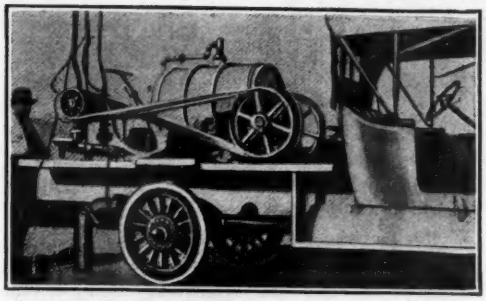
The following shows the amount of bodily heat diffused:

| | B.T.U. PER HOUR |
|---|---|
| Child six years old. . . . . | 240 |
| Adult at rest. . . . . | 380 |
| Adult at work. . . . . | 500 |
| Man 30 years old in an atmosphere with a temperature 68° F. . . . . | 440 |
| The same in atmosphere of 31° F. . . . . | 600 |
| Woman 32 years old. . . . . | 480 |
| Adult in old age. . . . . | 360 |

The amount of heat in B. T. U. usually assumed as given off per person per hour in an atmosphere of 70 degrees F. is 400 for adults and 200 for children. These are the figures generally used when the heating effect of the occupants of assembly halls or auditoriums is taken into account.—*Heating & Ventilating Magazine.*

## AIRPLANE DEVELOPMENT

The following statement of the National Advisory Committee for Aeronautics shows the development in airplanes which has been made since 1903. The first man-carrying airplane flights were made in December, 1903, with the Wright Bros. engine, developing 12 horsepower and weighing 152 pounds, or 12.7 pounds per horsepower. In 1910, the average horsepower for aeronautic engines had increased to 54, and the weight had decreased to 5.7 pounds per horsepower. After another seven years, in 1917, the average power output had advanced to 243 horsepower, and the weight had decreased to 2.8 pounds per horsepower. In March, 1918, the Liberty motor developed 432 horsepower for a weight of 808 pounds, or 1.86 pound per horsepower. At present, the Liberty motor is developing a maximum of 450 horsepower for a weight of 825 pounds, or 1.83 pound per horsepower. The average consumption of fuel decreased from about 0.8 pound per horsepower in 1903 to 0.55 pound in 1918, and for the Liberty engine to 0.50 pound. The present consumption is about 0.46 pound per horsepower.

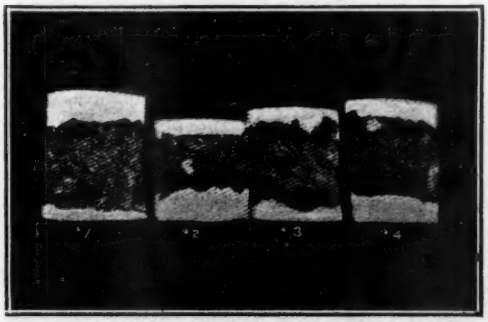


PORTABLE DRILLING RIG

## CORE DRILLING OUTFIT FOR PAVEMENT SPECIMENS

A Calyx core drilling outfit mounted on a light motor truck is employed by the testing division of the California Highway Commission for securing test samples from finished pavements. With this outfit a 4½-in. cylinder is cut from the pavement, furnishing very satisfactory specimens for compression tests.

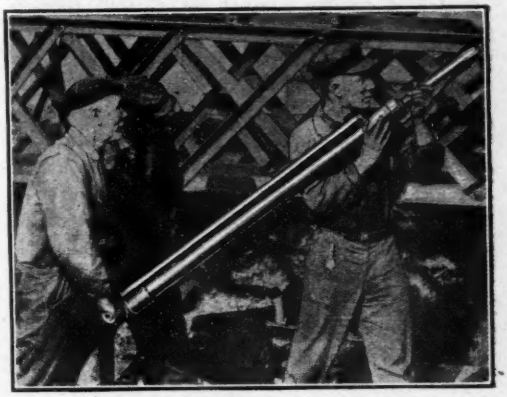
The drilling power is furnished by a 3-h.p. gasoline motor; the steel core cuts by grinding on the steel shot. Where the coarse aggregate of the concrete pavement is extremely hard and tough, the drilling takes from 30 to 40 minutes. The average concrete pavement can be drilled in from 6 to 15 minutes. The drilling of concrete pavement 5 or 6 years old made with gravel which consists largely of indurated sandstone required from 6½ to 10 minutes. Samples made of broken rock from a chert quarry were bored in from 10 to 12 minutes. Concrete made from boulders of extremely hard andesite required from 30 to 40 minutes. The actual time required for boring will be somewhat of an indication of the wear resisting qualities of the pavement. The borings taken from the pavement are valuable also in furnishing an exact record of the thickness and, also, in showing how thoroughly the concrete was mixed at the time of laying.



SECTIONS OF PAVEMENT

Tests by the laboratory of the finished pavement made with a 1:2½:5 mix at the end of 3 or 4 years indicates a total compressive strength in excess of 3,000 lb. per square inch.

The holes made in the pavement after the removal of the core are about 5½ in. in diameter and are usually repaired with neat cement and broken rock. When this mix is used, the cement sets up and gains sufficient strength in a few hours to make unnecessary any careful plan of protecting or curing the repaired holes.



## PNEUMATIC RIVET CUTTER

The "Red Devil" rivet cutter here shown in actual use is manufactured by the Rice Manufacturing Company, Indianapolis. It is intended for removing defective rivets in connection with structural steel erection or repair work, as well as for cutting apart old structural steel that is to be saved for re-erection at some other point. This rivet cutter is said to cut a 1¼-in. rivet in 10 sec. and to dispose of ⅞-in. and 1-in. rivets with from three to five blows.

The mechanical features of the device are simple. It consists essentially of a cold drawn, seamless tube about 5 ft. long with suitable fittings hydraulically pressed onto it at either end. The rear end is fitted with a valve by means of which air may be admitted into the rear end of the tube, while it is permitted to exhaust from the forward end of the tube through a rubber tube by-pass, or, by

giving the valve a quarter turn, the air may be admitted through the by-pass to the forward end of the tube and exhausted from the rear end. The forward end of the tube is equipped with a bushing designed to give a good fit for a chisel bit. The interior of the tube is occupied by a plunger ground to fit the tube with just enough clearance to enable it to slip readily from end to end, yet allowing a minimum of air leakage.

As shown in the photograph, three men are required to operate the cutter. One stands at the forward end to guide the bit while two carry the rear ends by means of suitable handles, one of them manipulating the valve lever. By replacing the valve in position to admit air to the rear of the tube, the plunger is driven swiftly against the chisel; then if the lever is given a quarter turn, air admitted through the by-pass returns the plunger to the rear end of the tube, while the air behind the plunger escapes through an open port. After a little practice the workman can operate the rivet cutter either fast or slow or strike heavy or light blows. This enables him to give a light blow when the rivet is almost cut off to prevent the head from flying. Springs in each end of the tube absorb all the shock of the plunger other than that given to the chisel, so it is not difficult to hold the device when in use. The rivet cutter weighs 65 lb. in an operating condition and has a total length of 58 in. Under average conditions three men operating the tool are said to cut from 25 to 33 times as many rivets as they could cut in the same time by hand.

## THE STIMULUS OF PIECE WORK

A New England manufacturer has in his factory a piece-work proposition on which the men employed earned on an average about $3 per day. The war reduced the force and the employer found it increasingly difficult and ultimately impossible to obtain a sufficient supply of men. Women have now been satisfactorily trained to do this class of work in the plant. Their diligence has made that $3 job worth $5 a piece to them every day. A visitor to the factory recently observed that according to the record of the operations performed now and formerly, three women were equal to five men! Even more interesting is the speculation as to what will be said should the men come back for their old places. And if they get them, what then?—*Iron Age.*

## SELF-STARTER OF THE LIBERTY ENGINE

The Liberty self-starter is an air motor and compressor in one. While acting as a starter it runs as a four-cylinder air motor, cranking the airplane engine through a train of gears, inclosed within its transmission. At the end of the transmission is a final drive that connects direct to the crankshaft of the engine. This drive runs continually at engine speed and operates a small pump which furnishes pressure for the petrol feed. After starting the engine the Liberty starter automatically disengages and remains so until needed for further use, either as a starter or compressor. In order to keep an adequate air supply in the tank the starter is engaged as a compressor by pushing a button on the control valve while the airplane engine is running at low speed. When engaged the engine must be speeded up to 1,200 to 1,400 revolutions per minute. At 230 pounds pressure the compressor automatically disengages. The Liberty starter is light, weighing but 30 pounds. It is compact, measuring but eight inches long. It is efficient, cranking the engine at 150 revolutions per minute or more and replenishing its own energy in 30 second. It is simple, as there are no pipes leading to the airplane engine, so that it leaves the airplane engine as it should be. The tank weighs 12¼ pounds, making the complete outfit 42¼ pounds.—*Scientific American.*

## MINERS EFFECTIVE IN THE WAR

We have frequently referred to the tunnelling work done by the Royal Engineers, aided specially by their Cornish contingent. Sir Douglas Haig thus refers to their labours in his despatch, of which we published a rather full synopsis last week: "The work of the tunnelling companies (he writes) has demanded, equally with that of the field companies, great courage and skill. In the period from August 8 to the termination of hostilities nearly 14,000 German mines and traps of various descriptions, totalling over 540 tons of explosives, had been discovered and rendered harmless by the different tunnelling companies, while a further amount of nearly 300 tons of explosives had been withdrawn from our own demolition charges and minefields."—*Mining and Engineering World,* London.

# COMPRESSED AIR MAGAZINE

EVERYTHING PNEUMATIC

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## FINISHING TOUCHES FOR NEW YORK

The necessary legislation having been accomplished and the money provided for, it is now assured that the vehicular tunnel under the North River to connect Jersey City with Manhattan will be commenced without delay and, thanks to compressed air, we know that the job will not take long. The undertaking has its special features of difficulty, chiefly, as far as can be anticipated, in the unprecedented diameter of the perforation, and the imperative conditions of ventilation, which must be fully operative immediately that the tunnel is put into service and maintained without a minute of cessation forever thereafter. This in itself is one of the most serious and exacting of engineering problems, but no one entertains a doubt as to a satisfactory solution.

In the meantime additional plans to provide for the growth and maintenance of the great city and to make it more convenient and desirable for the large transaction of business and for the improving and perfecting of the detail requirements for residence and recreation are continuing to be developed, and no one has any clear idea of what New York will be or how it will look when it is finished.

Immediately following this tunnel there will undoubtedly be others following close upon it, probably another of similar character and purpose with this and located some distance from it up or down the river. A tunnel to Staten Island also is among the inevitables and additional tunnels or subways traversing Manhattan both for passenger traffic and for freight distribution.

As to improvements of different character which are constantly suggesting themselves, both desirable and eminently feasible, there is practically no limit. One immediately in sight must soon become an urgent necessity, not only for New York, but for every large city, and that is a suitable area for the taking-off and especially for the alighting of the ships of the air.

In our next suggestion for municipal improvement it is difficult to assign any pneumatic interest. The horse must be abolished from our streets and it is high time to begin to talk about it. He is becoming now a great interferer with local traffic instead of a help to it, and he is the principal distributor of filth in all our thoroughfares.

In connection with the horse nuisance the influence of compressed air cannot be invoked either pro or con, but the air compressor stands ready to be the principal agent in the abolition of another most undoubtedly objectionable and most surprisingly tolerated intruder. The air compressor is employed in large units and in great numbers for the compression of natural gas to facilitate transmission. The gas so transmitted is also distributed at high pressure everywhere, and no one apparently has ever even thought of using the unsightly gas holders for the service. If they can be entirely dispensed with in natural gas service, how can they be indispensable for artificial gas?

## LIQUID AIR DEVELOPMENTS

The following is abstracted from a recent lecture by Sir James Dewar before the Royal Institution. He first of all traced some of the practical effects that have resulted from low temperature research. The final stage was Haber's discovery that when a mixture of hydrogen and nitrogen is passed over a catalytic agent (osmium was used first, and finally finely divided iron) at a high pressure of 200 to 250 atmospheres, and a temperature rather below red heat, the issuing stream of gas contains a proportion of ammonia, which can be obtained in a constant supply by absorption in water or by freezing with the aid of low temperatures. The nitrogen required was available in abundance, and pure hydrogen, was obtained by freeing water gas from impurities, again by the aid of low temperature. The oxidation of this ammonia yields nitric acid, a substance that is indispensable for the manufacture of modern high explosives. The importance attached by Germany to this process is indicated by the fact that it was made a State monopoly. In Germany one plant alone was making 100 tons of liquid air a day. How many of those plants there were is not known. but that single plant was producing nearly as much as the total daily production of all the plants in England.

The second main application of liquid air or oxygen mentioned by Sir James Dewar is for supplying the oxygen needed by airmen at high altitudes. It has the advantage over the method of carrying the necessary oxygen compressed in steel cylinders that it is very much lighter. The liquid air is stored in vacuum vessels, and, volatilized under the influx of heat, is conveyed in tubes to mouthpieces, from which it is breathed by the airmen. Sir James Dewar showed three methods by which the influx of heat, and with it the amount of oxygen given off, can be regulated. In the first electrical heating is employed, and in the second a rod of copper or aluminum, gradually screwed down into the vessel, conducts energy into the liquid and volatilises it. In the third the liquid air is simply siphoned out through a stop-cock into an evaporating chamber, which receives its heat from the outer air, and is then warmed up to air temperature by being passed through a series of coils before it reaches the mouths of the airmen. By adjusting the stop-cock the amount of air delivered can be readily regulated.

## GREATER CAPACITY WITH LESS PIPING

Pipe line engineers (oil) may find unusual interest in the plans of the Prairie Pipe Line Co. for its complete 65,000-bbl. pipe line system now in process of construction between Ranger, Tex., and Cushing, Okla.

The main principle embodied in the plans is the use of links of 12-in. pipe between each pump station, as being more economical than two additional continuous 8-in. pipes, and to give a greater capacity and ease of pumping.

When completed the arrangement of pipes between each pump station will be as follows: Starting from the pumps three 8-in. pipes will run out approximately a third of the distance toward the next pump station; for the remaining distance one 8-in. and a 12-in. pipe will carry the oil. The pump stations are at the usual intervals, approximately 40 miles apart. Pumps having a capacity of 20,000 bbls, will be used to start the oil off through the three 8-in. pipes.

The company has already demonstrated by 12-in. loops in other parts of its system that one 12-in. and one 8-in. at the outlet point coupled in proper ratio of distance with three 8-in. pipes coming from the inlet point, will increase the capacity of a continuous three 8-in. pipe line system by fully 10%—and this without additional pump power. As two 8-in. pipes cost more than a 12-in. of similar length a considerable saving in actual cost of pipe is effected. There is also a big saving in freight, drayage, and in putting the pipe down.

## COMPRESSED AIR FOR SHAFT SINKING

BY P. W. BROWN

A very interesting and successful use was made of compressed air in the sinking of a shaft through mud and sand at West Calder, Scotland, by Thos. Borland. The surface overlying the regular stratified beds consisted of over 100 feet of loose sand and mud, some 50 feet of which contained a moderate quantity of water. The method of sinking decided upon was that known as brick tubbing. In this method a cast iron cutting-shoe, V shaped, the diameter of the shaft is built up on the surface. The one side of this V is vertical, and the other inclined. The inside of the V is filled with concrete and a brickwork forming the shaft lining is built thereon, which in this case was 2 feet in thickness. The weight of brickwork is, in ordinary cases, sufficient to cause the crib to sink, more brick work being added and the loose material filled out from the inside of the shaft.

As the depth increased in this case the resistance became so great that even 24 feet of brickwork above the surface level failed to make the crib sink. Iron joists carrying bars of pig iron were placed on top of the brickwork, and this only carried the sinking of the crib a dsitance of 17 ft., despite the fact that the top weight reached 1,000 tons. As a result of the crib coming to a standstill it was decided to sink beneath the cutting shoe to find the cause of stoppage. About 2 feet below the crib had been sunk when a mishap occurred. The mud which was sunk through was tough all over the shaft bottom except at one point. Here it was soft and latterly it burst in, bringing with it sand and mud from above in such quantities that the shaft was half filled in the space of a few minutes. The inrush left a hole on the surface and extended down behind the brickwork.

To prevent further movement of the sand and mud behind the brickwork, it was decided to bore holes in the brickwork and fit them with pipes through which cement was to be injected. Before commencing cementation proper it was considered advisable to apply compressed air freely to each of the holes in order to make sure that each was clear to take in the cement. In the course of this operation a very interesting discovery was made. When the compressed air had been applied to eight or nine of the lower ring of holes an unusual commotion occurred, which began by a heavy escape of air from beneath the crib. On examination it was found that the sand filling the inside of the shaft was approaching the platform on which the workers were standing. When the air was turned off the movement ceased. Similar applications of compressed air again gave similar results. Closer examination disclosed the fact that the commotion was due not to the sand rising in the shaft but was due to the crib sinking, an entirely unexpected, but none the less welcome occurrence.

It appeared that the air had been sufficient to cause the sand and mud to loose their grip of the brickwork and to allow it to slide down as required. The sinking of the crib closed the hole caused by the inrush of sand. Earlier application of compressed air would have expedited the sinking and reduced the cost considerably. The cementation proposal was carried out, and it was effective in holding back the 80 gallons per minute of water which was formerly finding its way to the shaft bottom.

---

## CHEAPENING HELIUM AND OXYGEN*

When, at the suggestion of Sir William Ramsay, the British admiralty first studied the possible use of helium for balloon purposes they felt that the expense of production would be prohibitive. First, on account of the great scarcity of the element and the very great dilution in which it was found in the atmosphere and in other gases; and, second, because of the expense of the processes of separation then known to the admiralty.

When this information came to the United States bureau of mines it was remembered that some of the natural gases of Kansas had been found by Dr. H. P. Cady of the University of Kansas to have over 1 per cent. of helium in them. The separation of helium from these gases could best be accomplished by the same general processes of liquefaction and distillation as are used to separate air into its nitrogen and oxygen for industrial purposes.

It so happened that the metallurgical di-

*Dr. Frederick G. Cottrell, chief metallurgist of the Bureau of Mines, before the Chemists Club of New York.

vision of the bureau of mines had been making a study of these processes in the hopes of finding a way to sufficiently cheapen the production of oxygen from the air to allow its general use in metallurgical furnaces and other large scale chemical and industrial operations. If this were possible it would work a real revolution in these fundamental industries. Take, for instance, the smelting industry alone. We now concentrate everything that goes into the furnace except the oxygen of the air which we add with four times its volume of inert nitrogen and thus undo much of the effect of the concentration of the other constituents. It we could use pure oxygen, or more concentrated air, a great saving could be effected, and we could do in combustion furnaces much which is now only possible in the electric furnace.

One of the processes which the bureau has felt had much promise in this direction had not, up to this time, received any large scale development, but now these facts were all called to the attention of our army and navy, who immediately jointly appropriated first $100,000 and afterwards further sums now aggregating over $1,000,000, for trying out the project not only along the line of the new process but also parallel therewith by the older and better known processes as well, and entrusted the general direction of this work to the bureau of mines.

The plants on the older processes are already producing helium in large quantities and the one on the new and what is hoped may prove several times more economical is just about to have its practical production test. If it fulfills anticipations, its significance is far wider than the production of helium for it will open the possibility of oxygen in quantities at costs undreamed of by most chemists.

## EMPLOYING THE WINDS IN ROAD BUILDING.

Utilization of the elements in sand road construction, is the radical plan developed and repeatedly employed with success by D. W. Jones, district highway superintendent of Curry, De Baca, Guadalupe and Roosevelt counties, New Mexico. Ignoring all the old and conventional methods of road building across sand wastes, the Jones system has been employed on some 80 miles of highway in the border state with very satisfactory results. His system in substance is to throw a trench through the sand, extending down to the clay bottom and then let the desert winds finish the job.

First tests of the Jones system were made on the Delphos road in Roosevelt county. This experimental strip included a nine-mile sand stretch, seven miles of which consisted of sand more than 30 inches deep with pockets of unknown depth. The work was handled by a state highway crew under Jones' supervision.

Following the clearing of the right of way of grass and weeds, the first step in the experiment, the sand was taken out down to hardpan. Removal was accomplished with Fresno scrapers, and deposited in waste stacks at some ten feet from either edge of the cut. Bottom width of the cut was approximately 12 feet. Between high walls of loose sand a narrow strip of clay road was constructed and left to wind action. Spring and Fall winds swept away the sand remaining on the surface of the clay and widened the strip from its original 12-foot span to 35 feet over all for the entire nine-mile length.

Unusual irregularity marked the clay surface while sand pockets ranged from 30 inches to five feet in depth. Grading of the surface was delayed until the waste stacks by the roadside had disappeared and the widening of the surface by wind action had taken place. Where pockets were less than 30 inches deep they were left to wind action and vehicle travel to eradicate. Where pockets greater than 30 inches in depth existed, clay was hauled to fill them.

After three years test the Delphos road experiment proved so successful that the Jones plan was adopted on a dozen different sand beds in eight other counties of the state. These included the following: Clovis-Montrose sand bed, 7 miles; Kennes-Chaves county sand bed, 6.3 miles; Fort Sumner-Ricards sand bed, 10 miles; Evanola-Yeso sand bed, 5 miles; Thompson-Near road, 9 miles sand; Elida-Jenkins road, 10 miles; Portales-Loving road and Alamogordo-Newman road. The latter two stretches composed more than 30 miles of sand beds, sand hills and sand dunes and other obstacles of this nature. At present all of these roads are open to traffic and in almost every instance the worst stretches previous to the Jones treatment, now are the best.

## INFLAMMABILITY OF CARBONACEOUS DUSTS*

BY H. H. BROWN

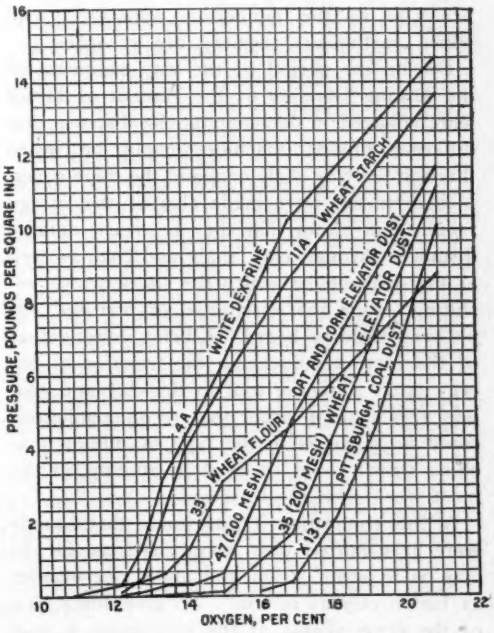
Severe property losses, in some cases attended by the destruction of human life, have occurred because of the fact that dusts from all materials which will burn are explosive. The Grain Dust Explosion Investigation Laboratory of the Bureau of Chemistry has investigated the explosibility of such dusts, with a view to ascertaining ways to reduce to a minimum the danger from dust explosions and fires in mills, grain elevators and cotton gins.

The relative inflammability of various dusts was determined in the laboratory, using a modification of the method devised by the Bureau of Mines for testing coal dust. Briefly, this method consists in forcing a cloud of dust (75 milligrams), which will pass through a 200-mesh screen, against a platinum-covered heating element, placed in the centre of a round glass globe with a capacity of approximately 1400 cubic centimeters. The pressure produced by the ignition of the dust was measured by a steam pressure gauge.

The results obtained from a number of tests conducted in this way indicate that the pressure (expressed as pounds per square inch) generated by the ignition of several different types of dust varies from 17.5 in the case of lycopodium and 15.2 for yellow corn dust from the first break in dry milling, through 13.2 for wheat starch, 11.3 for rice starch and 10.1 for Pittsburgh standard coal dust, to 3.2 for potato starch and 1.1 for gelatin dust from an elevator. Obviously, the dusts tested are highly inflammable, so that a cloud of any one of them suspended in the air forms a dangerous condition.

In the laboratory tests on the inflammability of coal dust, oxygen was employed to blow the cloud of dust against the heating coil, thus creating an atmosphere containing a greater amount of oxygen than is present in ordinary air. The pressures thus obtained exceed those secured when air alone is used. Conversely, lower pressures are shown when the surrounding air is deficient in oxygen.

A series of experiments was conducted to determine the possibility of employing an inert gas, or one lacking in oxygen, as a means for the prevention of dust explosives in industrial plants. The apparatus used was similar to that already described, with the addition of a device which permitted the filling of the explosion chamber with gas of any desired composition. In this way five typical dusts were tested, using gas mixtures ranging in composition from 16.9 per cent. oxygen, 4 per cent. carbon dioxid, and 79.1 per cent. nitrogen to 10.9 per cent. oxygen, 9.2 per cent. carbon dioxid, and 79.9 per cent. nitrogen. The results of this test are clearly shown in the accompanying diagram.




TESTS OF TYPICAL DUSTS

It is evident that an explosion of any of these dusts, which may be regarded as typical carbonaceous dusts of the more inflammable varieties, cannot occur in an atmosphere containing 12 per cent. or less of oxygen, the rest being inert gases. If elevator dusts alone are considered, this limit is extended to 14 or 14 1-2 per cent.

Tests conducted on a larger scale, using standard size milling machinery, have shown that it is possible to prevent explosions in these units by means of an atmosphere of inert gas. Results of such tests are now being prepared for publication.

*Journal Ind. Eng. Chem.*

## THE GEOPHONE FOR MINE SAFETY

The geophone, a listening instrument invented by the French during the war to detect enemy sapping and underground mining operations, and for the location of enemy artillery, is now being used by the United States Bureau of Mines as a possible aid in locating miners who have been entombed after a disaster. The instrument was developed by United States engineers during the war and is now used by the bureau according to plans drawn by these engineers.

The instrument, though small, is essentially a seismograph, since it works on the same principle as the ponderous apparatus with which earthquake tremors are recorded.

During the period of the war engineers of the Mining Division of the Bureau of Mines were engaged in determining the distance that different mining machines could be heard through the clay shale coal and the mine cover. Measurements were made also of the energy required in blows that they be heard definite distances through clay, shale and coal, as well as the distances at which the shock waves resulting from the discharge of various explosives could be heard. A brief investigation of the factors influencing the transfer of energy from a mining tool to the clay and coal was also made in order that recommendations could be made as to the type of mining machine which could be used to accomplish the most work with the least noise.

In this connection it was found that sounds were transmitted only about half as far in clay as in shale strata and about one-quarter as far in clay as in coal. To give some idea of the sensitiveness of the instrument it may be said that pounding with a pick on the bituminous coal can be detected for a distance of 900 feet and the direction determined, and that pounding with a sledge can be heard as far as 1,150 feet. These measurements were made in the Pittsburgh coal seam in the vicinity of Pittsburgh, where the coal is somewhat harder than in most other bituminous coal beds. The explosion of a one-ounce charge of dynamite was detected a distance of over 2,000 feet through the shale strata. One interesting feature of the instruments is that the sound as transmitted to the ear is very characteristic of the instrument producing the sound. To illustrate: Twelve mining and carpentering operations were carried out on the coal rib. An engineer of the bureau who had never used the geophones and who did not know what tools were to be operated was able to recognize and name nine of the instruments at a distance of several hundred feet through the strata. The other three sounds were accurately described, but the machines were not identified.

Now that the war is over the bureau work has turned to the development of the instruments for peace time uses. In this connection it is thought they may be of great value to mine rescue crews who may be entering mines for exploration and to locate miners who may have been entombed after a disaster. The tests so far made in the vicinity of Pittsburgh show that a man pounding on the coal rib with a pick, piece of timber, or a sledge can be detected and located from a point 600 to 1,200 feet distant. This distance depends greatly on the character of the coal upon which the man is pounding, and intervening rooms and entries seem to have surprisingly little effect upon the distance or the determination of direction.

It is also thought that they will be of value to prevent accidents from explosions when breaking through. In this connection an interesting incident happened recently. Observations were being made at a tunnel heading. The pit boss happened along and asked to be allowed to listen. He put the ear pieces in his ears and remarked: "Mack is tamping in a charge, we had better move away."

## VARIOUS FAN DATA

The theory of fans, although simple, cannot entirely be applied in the construction of fans. Each maker calculates his designs upon coefficients obtained from experiments with earlier fans, and these coefficients, as well as the constructive details, vary widely. For the same output fans differ in speed, diameter, width, height, and angle of vanes. From the curves for pressure and power referred to the delivery volume and efficiency curve can be deduced. The problem for the builder is to construct a fan to deliver the desired volume under the desired pressure at the highest possible efficiency—that is, with the least expenditure of power. The theoretical pressure-volume curve is a straight line, but the actual curve is of parabolic form, with probably only one point common to both curves.

The author of a recent article illustrates a series of nine vane angles for a given fan and discusses their relative merits, pointing out that it is now considered desirable to couple the electric motor direct to the fan, which must run at a high speed to keep the cost of the motor down.

The Oerlikon Machine Company instructed the author to make a series of tests to decide upon the best angle of the vanes. Three fans, precisely similar except for the angle of the vanes, were tested in the same case at the same speed, and the results are plotted in the form of curves, and from these the three curves of efficiency are shown together so as to be readily compared. The maximum efficiency attained was 78 per cent.; the delivery was then 3.25 cubic metres per second, and the speed 1,400 revolutions per minute; the pressure was 242mm. of water, and the power required was 12.25-hp. He also gives curves for a smaller and a larger fan; the former showed an efficiency of 64 per cent., with a delivery of 40 cubic metres per minute and pressure of 78 per cent. of water, with 1.06-hp., while the latter gave 86.8 per cent. efficiency, with 3.78-hp., delivery of 110 cubic metres per second under a pressure of 228-mm. of water. These results are stated to agree very closely with the theoretical calculation.

## WESTINGHOUSE NOT TO BE BRAKED*

After Westinghouse had developed the plans of his first air brake, he laid them before many different railway men. He met with rebuff after rebuff. Finally a man named Baggaley, of Pittsburgh, became interested in Westinghouse and his schemes, and Baggaley wished to put some money into development work. Westinghouse, however, was reluctant to let his friend assume the risk till both felt sure they were on solid ground. Baggaley suggested that they submit the plans and drawings of the brake to the best mechanical expert in Pittsburgh.

Westinghouse consented, and this was done. The expert gave the subject his careful scrutiny, and in the course of a fortnight handed back a written opinion, which was read with feverish eagerness. It was a sweeping condemnation of the whole scheme as not only unsound, but nonsensical. Baggaley hurried with the paper to Westinghouse, who went over it twice before handing it back. The rising color in his face showed that he was angry, but he gave no immediate vent to his feelings.

"How much did your expert charge you for that death sentence?" he asked after a little.

"One hundred dollars."

"Well, what are you going to do about it?"

"Watch me and see." And Baggaley, setting his teeth hard, tore the manuscript into ribbons and threw it into the grate. As it did not catch at once, he struck a match and lighted the little pile, standing over it till the last fragment of paper had been turned into ashes, and the smoke from it had disappeared up the chimney."

And they went ahead.

Again in 1887 Westinghouse met disappointment. In the Burlington trials his air brake was in competition with a number of brakes of other makes.

The Committee's report was generally favorable to a brake operated by air, having valves operated by electricity—a verdict against brakes operated by air alone.

Among the technically trained observers probably the only one who did not read in this turn of affairs an end of the dominance of Westinghouse in his special field was Westinghouse himself. To a friend who attempted to say something comforting, he turned a face, which, though serious, was entirely cheerful.

"What are you going to do now?" asked the friend.

"What I have left undone hitherto," he answered—"perfect my air brake."

*W. E. Woodward, at N. Y. Railroad Club.

## HIGH OR LOW VACUUM

The lack of a separate system of terminology for mechanical pressure is due, no doubt, to the self-suggesting analogies with altitude, which made the old altitude expressions readily understood in their new applications. It is really difficult to imagine anything more natural than that a large number of pounds pressure should be spoken of as "high," or that a relatively small number of pounds should be known as "low." It is only when we go below the datum level of atmospheric pressure that the analogies become less appar-

ent, and we find ourselves groping among needless inconsistencies and foolish contradictions.

Take a homely example. A man whose property is 500 feet above sea level erects a flagstaff 80 feet high. The top of his flagstaff is 580 feet high, if he is speaking to a topographical engineer; and it is 80 feet high, if he is reeving off halyards. The steam engineer follows him exactly with 14.7 pounds per square inch corresponding to the 500 feet elevation, 200 pounds aboslute corresponding to the 580 feet, and 185.3 pounds gage corresponding to the 80-foot flagstaff. But suppose the property owner digs an 80-foot well. The bottom of the well is 420 feet "high" above sea level; and it is also 80 feet "deep" when referred to the surface of the ground—being "high" or "low" according as it is viewed from sea level or from the locality. The steam engineer makes fairly good weather of it so long as he speaks of "one pound absolute pressure," but he gets hopelessly lost when he looks down 13.7 pounds below atmospheric pressure and calls it "28 inches vacuum." He is almost sure to call it a "high" vacuum, which might be permissible, if we could also speak of a "high" well. It is almost equally certain that he will speak of "amount" of vacuum, whereas a man who spoke of "amount" of well or "amount" of flagstaff would be tapped for the simples.

Since we have irrevocably adopted the altitude ideas of "high" and "low" for expressing the relative degrees of pressure, and, since it is unquestionably desirable to be consistent throughout the entire range, it is suggested that the term "deep vacuum" be used instead of "high vacuum," and that the term "depth of vacuum" be used instead of "height of vacuum," "amount of vacuum" and similar expressions—*Q. B. Newman, in Marine Engineering.*

## NEW JOB FOR SAND HOGS

In our list of U. S. patents in our present issue there is one covering a process for making hollow rubber articles and the first claim of the patent is as follows: The process of making hollow articles of plastic material consisting of bringing the parts together within a room occupied by the operator and containing air under pressure.

## NOTES

The following is in a bill before the Missouri legislature: "The county highway enengineer shall receive the same compensation as is now provided by law for the prosecuting attorneys in the various counties of this state, and his salary shall be computed and paid on the same basis as now provided by law in relation to the office of prosecuting attorney."

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A novel application of cold storage is mentioned in *Chambers's Journal.* Fruit farms in California were troubled with a plague of aphides, so ladybirds were gathered from their hibernating places and put in cold storage until the greenfly began to appear next season. The ladybirds quickly exterminated the aphides.

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If you believe that prices of commodities are going to drop all of a sudden, then don't plan for to-morrow at all! Don't buy a new shirt or a new collar or a new suit of clothes. May be next week they'll only cost half as much as they do to-day! May be! But the man who would act according to such a rule would be standing still, and perish in the dry rot while the rest of the world is going ahead.

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Slate pencils made of talc are now being manufactured in Johannesburg, South Africa. In order to meet the large demand which has developed, a new machine has been designed, and is being made locally, which will be capable of turning out about 40,000 pencils per day. From this we may infer that they have not yet thrown away their school slates.

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It is mentioned in the *Scientific American* that the General Electric Co. has conducted experiments on ingot iron with a view to determining how soft this iron may be made by proper treatment. It is stated that if ingot iron is surrounded by hydrogen for three hours at 1,600 degrees F., and slowly cooled, it will become about as soft as soft copper.

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A British newspaper, commenting on the deplorable state of affairs in Belgium, states that shortly after the Armistice was signed the need for sewing cotton was found to be so great that a ton was immediately despatched by aeroplane.

Prices—and wages—are not going to come down in a hurry. Even if it does cost you more to produce an article, more to live, than before the war, you are also getting better prices—better wages. There's a new price level all around.

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Hair Driving Belts were first considered as an economic possibility as soon as the Chinese as a nation came to the conclusion that the possession of a pigtail was not an essential passport to heaven. A large number of discarded queues were utilized in the manufacture of driving belts, being made up with coarse camel hair and wool rejects.

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A doubtful period is the wrong one in which to hesitate. When in doubt, boost—push—hustle! Dig up all those odds and ends of business you once considered too small to bother with. Keep up your stock as well as your good spirits. Look prosperous, and pretty soon your neighbors will begin to think you are prosperous. And, when they see that you are kept busy while your competitors are stagnating, they will naturally conclude that you are the best man in your line to do business with—and, before long, you will really *be* prosperous. If conditions don't suit you, change them! Make prosperity!—*Du Pont.*

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Equinoctial disturbances in the shallow rivers back of the Gulf of Mexico have called the attention of natives to a somewhat neglected method of procuring dyes. The waters abound in cuttle fish, which are now being driven ashore, and which, when alarmed exude a black, paste-like substance which discolors the water and hides the fish from view. This substance gradually comes to the surface in a foam and can be kneaded, pressed into cakes, sold and eventually made into inks or dyes.

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In discussing the possibilities of cutting cast iron by means of the acetylene blowpipe, *Teknisk Tidskrift* says that heavy castings can be perforated in a few seconds by blowing the flame through a wrought iron tube in which iron wires are inserted. The part to be operated on is first brought to a bright red heat with an ordinary flame, and immediately oxygen at an initial pressure of 15 atmospheres is admitted the molten metal is thrown out with such force that the work cannot be performed without asbestos clothes and gloves. Castings 2 ft. thick, it is said, can be perforated in two minutes and large castings removed in pieces by fusing holes in suitable places, and allowing the castings to crack as they cool.

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Writing in the *Monthly Weather Review*, Mr. George N. Cole sets forth detailed arguments to prove that the hot blast which swept over the city of St. Pierre during the eruption of Mont Pelée, as well as similar blasts in connection with the eruption of Vesuvius that destroyed Pompeii and Herculaneum, the eruption of Taal, Sakurajima, etc., derived its heat from the sudden compression of the air surrounding the volcano, and not from conditions in the volcano itself. In other words, it was not, according to this hypothesis, an outpouring of hot crater gases that caused the destruction, but the dynamic heating of the air attending the propagation of the explosion wave. Mr. Cole cites a number of interesting observations at St. Pierre after the Martinique disaster that seem to support this idea.

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## LATEST U. S. PATENTS

*Full specifications and drawings of any patent may be obtained by sending five cents (not stamps) to the Commissioner of Patents, Washington, D. C.*

FEBRUARY 4.

1,292,987. AUTOMATIC TRAIN CONTROL AND SIGNAL APPARATUS. William E. Backus, Fitchburg, Mass.

1,292,988. AIR-PRESSURE PLUG. Mark J. Bacon, May, Cal.

1,293,041. GAS-MIXER. Frederick A. Coleman, Cleveland Heights, Ohio.

1,293,080. FLUID-MOTOR. George H. Gilman, Claremont, N. H.

1,293,081. DRILL-TOOL. George H. Gilman, Claremont, N. H.

1,293,178. PNEUMATIC CONTROLLER. John L. Osborne, Rochester, N. Y.

1,293,225. ROCK-DRILL. William A. Smith, Denver, Colo.

1,293,227. FLUID-PRESSURE GOVERNOR. Arthur L. Smyly, Chicago, Ill.

1,293,250. SUCTION CLEANING APPARATUS. Walter G. Trautman, Cleveland, Ohio.

1,293,251. SADDLE FOR PNEUMATIC HAMMERS. Robert J. Troeger, Los Angeles, Cal.

1,293,262. FLUID-MOTOR. Timothy T. Walker, Buffalo, N. Y.

1,193,294. VACUUM-INSULATED VESSEL AND CASING THEREFOR. George P. Altenberg, Cincinnati, Ohio.
1,293,396. GAS-OPERATED MACHINE-GUN. Ansley H. Fox, Philadelphia, Pa.

FEBRUARY 11.

1,293,663. MEANS FOR COOLING COMPRESSED AIR ON LOCOMOTIVES. Earl A. Averill, Mount Vernon, N. Y.
1,293,683. VACUUM-FUEL-FEED DEVICE FOR INTERNAL-COMBUSTION ENGINES. James L. Breese, Jr., Washington, D. C.
1,293,729. WIND-INDUCING DEVICE FOR SELF-PLAYING MUSICAL INSTRUMENTS. Lewis B. Doman, East Syracuse, N. Y.
1,293,789. VALVE MECHANISM FOR VACUUM FEED DEVICES. Webb Jay, Chicago, Ill.
1,293,790. MULTIPLE-ACTION VACUUM FEED DEVICE. Webb Jay, Chicago, Ill.
1,293,886. ENGINE STARTING DEVICE. Horatio N. Norton, Los Angeles, Cal.
1,293,896. ELECTRIC FLUID-HEATER. Jens A. Paasche, Chicago, Ill.
1,293,933. POP-GUN. Ernest S. Roe, Plymouth, Mich.
1,293,960-1. ROCK-DRILL. William A. Smith, Denver, Colo.
1,294,058. PNEUMATIC STARTER FOR AUTOMOBILES. Thomas Davis, Detroit, Mich.
1,294,073. AUTOMATICALLY-CONTROLLED HUMIDIFYING APPARATUS. Guy S. Faber, Springfield, Ill.
1,294,103. VACUUM LIFTING DEVICE. Halbert K. Hitchcock, Pittsburgh, Pa.
1,294,188. PRESSURE-CHAMBER FOR REMOVING DIVERS' DISEASES. Hermann Stelzner, Lubeck, Germany.
1,294,190. AIR-BRUSH AND SIMILAR APPARATUS. Herman Edward Sturcke, Brooklyn, N. Y.
1,294,266. PNEUMATICALLY - OPERATED ELEVATING MECHANISM. Frederic W. Hogg, Hillsdale, Oreg.
1,294,271. METHOD AND APPARATUS FOR RAISING OR FORCING LIQUIDS. Merbert Alfred Humphrey, London, and William Joseph Rusdell, Dudley, England.
1,249,319. GLASS-BLOWING MACHINE. Frederick W. Stewart, Beaver, Pa.

FEBRUARY 18.

1,294,369. AUTOMATIC AIR-GAGE. George L. Banks, Huntington Park, Cal.
1,294,468. MOTOR-DRIVEN SUCTION-SWEEPER. Emma Hunsicker, Milwaukee, Wis.
1,294,473. VACUUM-CLEANER. James B. Kirby, Cleveland, Ohio.
1,294,532. FLUID-DISTRIBUTING VALVE MECHANISM. Demetrius M. Radovanovitch, Pittsburgh, Pa.
1,294,551. HUMIDIFYING OR SPRAYING APPARATUS. Herbert Smethurst, Hollinwood, England.
1,294,808. DEVICE FOR ACCUMULATING WAVE-POWER. Charles Francis Jenkins, Washington, D. C.

1. In apparatus of the class described, the combination with a compressed air chamber, of a passage leading into said chamber and open to receive incoming waves of water, a check valve located in said passage in position to receive the impact of incoming water and to allow it to enter the chamber and prevent its return, a reservoir at a higher level than the chamber, a conduit leading from the chamber to the reservoir, and a check valve allowing water to pass, in the conduit, toward said reservoir and preventing its return.

1,294,869. AIR-COMPRESSOR. George P. Bump, La Crosse, Wis.
1,294,870. COMPRESSED-AIR STARTING APPARATUS. George P. Bump, La Crosse, Wis.
1,294,875. SUCTION CARPET-CLEANER. Frank S. Chase, Torrington, Conn.
1,294,877. WIND-MOTOR. James H. Connolly, El Paso, Tex.
1,294,910. AIR-MOTOR. Valentine G. Hyatt, Jr., Welby, Utah.
1,294,978. FLUID-PRESSURE BRAKE. Walter V. Turner, Wilkinsburg, Pa.
1,295,000. AIR HEATING AND REGULATING MEANS FOR INTERNAL-COMBUSTION ENGINES. Howard Brooks, El Paso, Tex.
1,295,010. FLUID-PRESSURE BRAKE. William E. Dean, Wilmerding, Pa.
1,295,036. VACUUM FUEL-FEED DEVICE FOR INTERNAL-COMBUSTION ENGINES. Webb Jay, Chicago, Ill.
1,295,089. METHOD OF AND APPARATUS FOR TREATING GUNCOTTON AND THE LIKE. Frederick D. Crane, Montclair, N. J.

5. The herein described method of preventing the premature explosion of a mass of wet gun cotton while being treated in a centrifugal drier, which consists in suddenly reducing the pressure of the gaseous medium surrounding the mass at a definite stage in the drying process, whereby the resulting rapid vaporization of the contained liquid serves to cool and loosen up the mass.

FEBRUARY 25.

1,295,198. PIANO-PLAYER. Claus E. Peterson, Worcester, Mass.
1,295,248. PNEUMATIC SYSTEM FOR CLEANING COAL OR ORE. William E. Winn, Pittsburgh, Pa.
1,295,235. AIR-BRAKE SYSTEM. Earl G. Taylor, Bellevue, Pa.
1,295,247. AIR AND GAS MIXING DEVICE. Robert W. Wiederwax, Atlantic City, N. J.
1,295,256. DIRECT MOTOR-DRIVEN COMPRESSOR FOR AIR AND OTHER FLUIDS. Mario Balloira, Turin, Italy.
1,295,282. AUTOMATIC AIR-BRAKE-HOSE COUPLING. Samuel M. Dick, Minneapolis, Minn.
1,295,416. AIR-CONDITIONING APPARATUS. Arthur Francis Berry, London, England.
1,295,417. COOLING OR COOKING BOX. Arno Boerner, Scheveningen, Netherlands.

1. An apparatus of the character described, comprising a casing having an airtight cover and adapted to receive the food or the like to be treated, a jacket surrounding the casing and forming an air space, a second jacket surrounding the first jacket and forming a water chamber, means for permitting water to flow through said chamber, and means for evacuating the air from said air space.

1,295,422. AIR-COOLED STORAGE-HOUSE. Alfred G. Brown, Chicago, Ill.
1,295,446. PNEUMATIC WATER-ELEVATOR. Felix Denizet, Perryville, Mo.
1,295,451. GREASE-GUN. Edward J. Duffey, Seattle, Wash.
1,295,471. PNEUMATIC JACK. Louis A. Fleury, Indianapolis, Ind.
1,295,491. AUTOMOBILE-TIRE PUMP. George E. Hazard, Rochester, N. Y.
1,295,511. COW-MILKER PUMP. Magnus Edward Jernberg, Cowdery, Manitoba, Canada.
1,295,529. AIR-COMPRESSOR. James W. Lawhead, Wilmington, Ohio.
1,295,635. PROCESS FOR OBTAINING NITROGEN FROM AIR. Nobile Carlo Tommasi, Basel, Switzerland.

1. The described process for obtaining nitrogen from air wherein the air is passed through a solution of ammonium sulfite on the counter-current principle until the oxygen has been removed from the air to such an extent that the remaining nitrogen contains less than 1 per cent of oxygen.

1,295,668. PNEUMATICALLY - OPERATED MUSICAL INSTRUMENT HAVING HAMMERS. Adalbert Zollinger, Leipzig-Eutritzsch, Germany.
1,295,672. PNEUMATIC ACTION FOR MUSICAL INSTRUMENTS. Willis E. Austin, Minneapolis, Minn.
1,295,724. AIR-REFRIGERATING MACHINE. Julius Frankenberg, Chicago, Ill.